

The Blast Furnace *and* Steel Plant

Vol. XII

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No. 2

The President's Thrift Message

PRESIDENT COOLIDGE'S thrift week message to the people of the country is contained in a letter addressed to Lew Wallace, Jr., Director of the United States Government Savings System:

"The growth of thrift and saving in this country promises well for our future. Only through sacrifice and hard work can we attain the cherished things in life. This means we must work and save.

The program of the United States Government Savings System, in giving to all our people an opportunity to invest in safe securities, is most worthy. By placing Treasury Savings Certificates on sale in post offices, banks and trust companies, the Government has made available to everyone a security of unquestioned soundness. Their widespread sale makes for better citizenship, as each purchaser holds a stake in his Gov-

ernment. I believe, also, that the enlargement of a national Thrift movement will eventually stamp out the false and unsound practices of the swindler.

For the men and women who want to get ahead, and for the boy or girl who can save only a little at a time, Treasury Savings Certificates are a security which can be compared in safety and interest return with the securities which are available only to those of larger means. The growth of the United States Government Savings System will result in increased happiness for the individual, and increased prosperity in general, for prosperity and happiness go hand in hand and are dependent upon the financial soundness of both the individual and community."

(Signed)

CALVIN COOLIDGE

Inland Steel Electrically Operated

Steam Driven Units Rapidly Being Replaced by
Electrical Equipment

By F. J. CROLIUS

PART II

AS this article was primarily written to give a description of the power generation and distribution system, it might be well to go back some 14 years to show the reasons for the additions to equipment due to the rapid growth of the plant. The original power house was located at the blast furnaces in plant two, and consisted of three 550 k.w., 250 v., d.c., direct connected, engine driven generators, operating at 100 r.p.m. The engines are cross compound, and operate from gas fired boilers, using excess gas from the blast furnaces for the generation of steam. The switchboards consisted of the necessary generator panels, blast furnace feeder panels and a 6,000 ampere feeder panel, which was the supply circuit for plant one. These feeders consisted of 10 1,000,000 c.m. cables per side, which, in turn, were connected to a distributing switchboard located in plant one. This switchboard was located in the electrical repair shop for convenience, and consisted of four 3,000 ampere, 14 2,000 ampere and eight 1,000 ampere circuit breakers.

With the addition of the bolt and rivet department and eight additional sheet mills, two units of the same

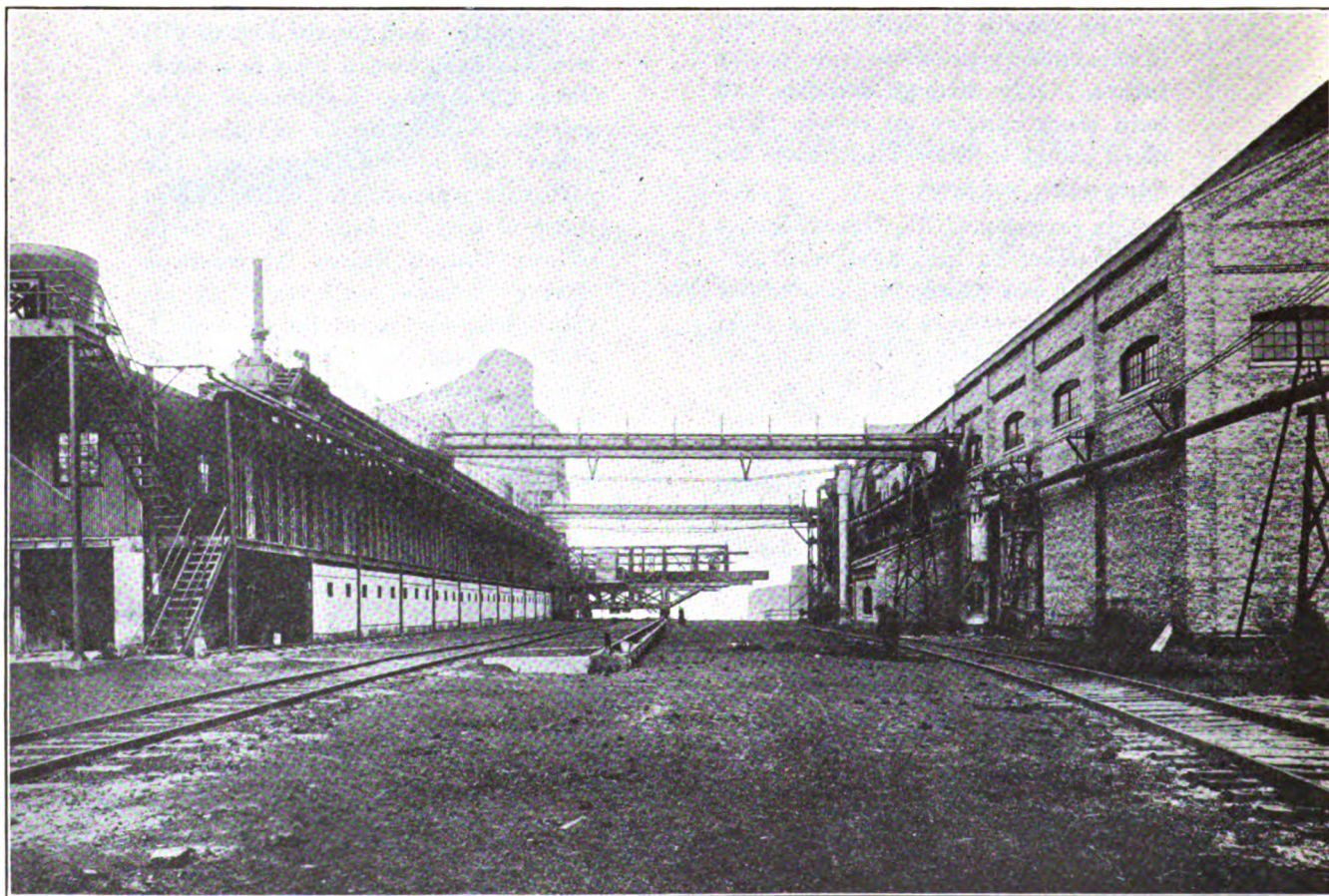
operating characteristics were added to the original power house, making a total of five.

First Motor Driven Mills.

In 1912 it was decided to build a plate mill, and, after survey was made of the different conditions, it was decided to drive this mill with a motor, and to, also, change No. 1 sheet mill from engine to motor

In the January issue, the general features of the Indiana Harbor plant were outlined historically. This second section incorporates a description of the By-product Coke Plant by Mr. de Holl, and many interesting features of the electrical development by Mr. R. L. McIntosh, Electrical Engineer.

drive. The exhaust steam from the 36-in. blooming mill and 24-in. bar mill was utilized; by use of proper regenerators, enough power was recovered to warrant the installation of two low pressure steam turbines, 2500 k.v.a., 2300 v., 3-phase, 25 cycles.



The complete by-product coke plant consists of 130 Koppers ovens, with direct ammonium sulphate recovery system, and the first benzol plant erected in America by the company.

During this year a by-product coke plant, with 66 ovens, was installed at plant two, adjacent to the blast furnaces, two additional generators were added, of the same capacity and characteristics, making a total of seven units. These seven units completed the generating equipment of this station, and supplied all the d.c. power for the mills up to the year 1917.

As there was excess low pressure steam for the operation of the turbo-generators, additional equipment, such as hydraulic pumps, condenser pumps and fans, were supplied with power from this station at 2200 v.a.c. As low pressure steam is not always available, due to mills being down waiting for steel, and other delays, the turbines are supplied with live steam, through a large reducing valve, into a low pressure header, and also are equipped with valves operating from the governor, which admit live steam on the occasion of an overload, to maintain the speed of the turbine during this period.

Description of the Coke Plant.

During the navigation season the coal used for coking purposes is shipped from lake ports in boats and unloaded at the Inland Steel Company's dock at Indiana Harbor. Two unloading towers transfer the coal from the boats to a series of bunkers. There are also five ore bridges which may be used to supplement the work of the coal unloading towers in rush periods. The coal is discharged from the bunkers by means of a shaker feeder onto a conveyor belt and thence over a series of conveyors to one of two traveling coal bridges spanning a coal storage yard of 200,000 tons capacity. Each bridge is equipped with a grab bucket, a conveyor belt, and a tripper which can be set to dump the coal at any point along the belt.

The work of unloading coal from boats is expedited by the use of a double track hopper located at the dock, and two electrically operated transfer cars which carry the coal from the towers and bridges to the hopper. Shipments of coal received in cars are also unloaded here and conveyed to the storage yard.

Coal is taken from the storage yard by the bridge crane grab buckets, loaded into a track hopper located near the coal handling equipment of the coke plant. A system of conveyors carries the coal from this point to one of two roughing tanks, one for low volatile and one for high volatile coal. Beneath each roughing tank there is a system consisting of a Bradford breaker, a bone coal crusher, and two hammer mills. Having the two systems permits of crushing two kinds of coal at the same time. Twin conveyor belts carry the crushed coal to the mixing bins, of which there are three. Adjustable gates at the bottom of the mixing bins permit as many as three kinds of coal to be fed on the mixing conveyor belts in any proportion desired.

After passing through the mixer, the coal is conveyed by belt to two storage bins of 1,300 tons capacity each, located over the ovens. Two charging cars take the coal from the storage bins over the top of the batteries to the ovens about to be charged.

There are three batteries, consisting of a total of 130 of the well known Koppers cross-regenerative ovens, having a capacity of $13\frac{1}{2}$ tons of coal per oven.

Three pushers and five door extractors and coke guides comprise the equipment available for pushing the coke from the oven. The quenching car, drawn by a steam locomotive, carries the coke to one of two

quencher stations, where the coke is quenched. After draining a short time, it is dumped on an inclined coke wharf, where excess moisture is driven off. Hand operated gates allow the coke to slide onto a mechanical feeder and thence to a conveyor belt which carries the coke to a crusher. From the crusher the coke is conveyed to one of two screening stations equipped to make the separation of blast furnace coke, domestic and braize. The braize and domestic coke drop through chutes directly into cars, while the blast furnace coke is run into the cars from a boom conveyor which can be lowered into the car, thus preventing excess breakage.

One of the screening stations is equipped with two elevator buckets into which coke can be emptied directly from the quenching car. These are used in emergencies when the belt conveyors or coke wharf are under repairs. This arrangement prevents delays, which, in causing an enforced change in coking time, would tend to give a non-uniform quality of coke.

The gas leaves the batteries by means of five cross-over mains, joining a common foul gas main. This main is so arranged that the gas from 66 ovens can be sent through one set of by-product apparatus and the remainder through another set, or the entire output of gas can be put through one set of recovery apparatus.

The by-products plant (Koppers direct ammonium sulphate recovery system) consists of two series of tubular primary gas coolers, three in each series (two coolers in each series are always in use, leaving one for a spare); three trains, each comprising one steam driven turbo-exhauster, one tar extractor, one reheater, one saturator and two salt dryers. Under present operating conditions two trains are constantly in use, leaving the third for a spare. The apparatus in one train is interchangeable with that of another. The ammonia liquor condensed from the gas is distilled in one or two ammonia stills, the vapor entering the gas main immediately before the saturators. The salt is handled in the storage room by an electric crane.

The benzol plant, the first erected in America by the Koppers Company, was completed in record time. Ground was first broken on March 17, 1915, and the plant was in operation on May 19, 1915, a period of two months and two days. To accomplish this feat and to secure immediate delivery on castings and other material, it was necessary to place orders with different concerns located in practically every part of the country.

As first constructed, the benzol plant consisted of two final gas coolers (designed to cool the gas flowing counter current in direct contact with water), three gas scrubbers, two continuous light oil stills, one agitator, one crude benzol still and three pure benzol stills. In 1917 the size of the plant was increased 50 per cent by the addition of a series of two final coolers, one continuous light oil still, one agitator, one crude benzol still and one pure benzol still.

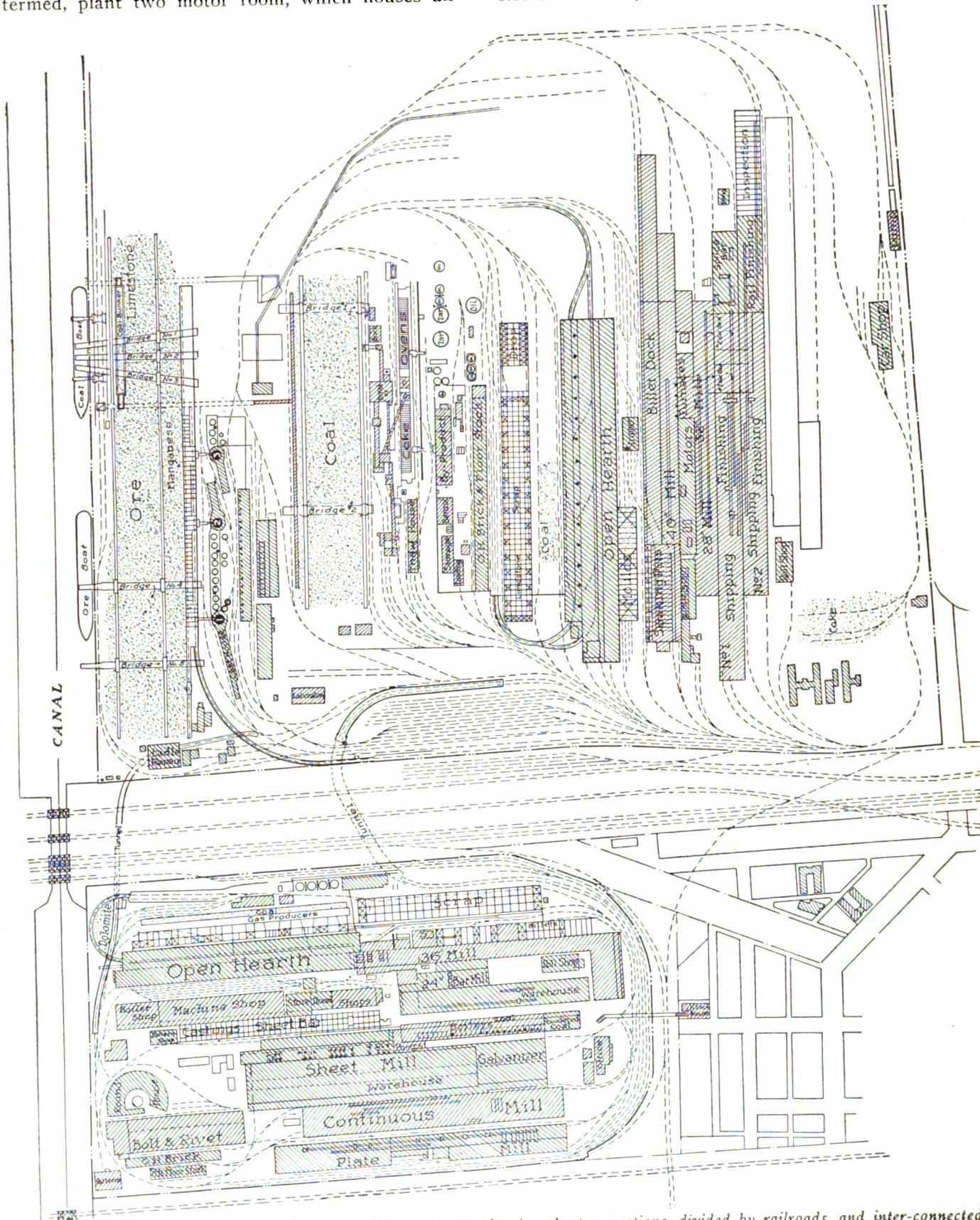
The present storage capacity consists of five 20,000-gallon tanks and one 100,000-gallon tank for pure products, and eight tanks having a total capacity of 135,000 gallons for crude and intermediate products.

During 1916-1917, Inland Steel Company installed, and put into operation, a complete steel plant, with all necessary furnaces, rolling mills and other equipment for the manufacture of blooms, billets, slabs and struc-

tural shapes. These mills are the latest developments in steel mill design, and are entirely electrically operated, all main drives being of the reversing type.

Located centrally within the rolling mills is, what is termed, plant two motor room, which houses all

the main drives and regulating equipment, and is also a continuation of the new power house necessary for the generation of power for the new mills. The generating equipment, as installed at that time, consisted of two 5,000 k.v.a. turbo-generator units, 2300



Reproduction of the general plan of Indiana Harbor plants, showing the two sections, divided by railroads, and inter-connected by tunnels.

v., 25 cycle, 3 phase, and are connected to a bus structure located in the basement. This structure is built of special brick, the barriers between the buses being Transite board, two inches thick. Bus bars are supported by heavy type pedestal insulators, held in place by means of bolts set in special concrete blocks. This structure carries a single bus circuit and contains necessary switching apparatus for the different main drives, transformer stations, main pumping stations, and main breakers for the synchronous motor-generator sets for the conversion of power from a.c. into d.c. There were two synchronous motor-generator sets originally installed, but one more has been added lately. These three units are 1,000 k.w., 250 v., d.c., and are of the same make and operating characteristics.

Due to other departments being added at this plant, such as rail finishing equipment, splice bar and tie plate units, it was necessary to increase the capacity of this station. There has been added, one 12,500 k.v.a. turbo-generator unit, 2300 v., 3 phase, 25 cycles, connected to a separate bus structure, parallel with the original structure, and located in a dust proof leanto outside of the main building.

The two structures are electrically tied together by means of an oil switch with instantaneous trip and set for the full load capacity of the large unit. In case of a disturbance on any of the feeder circuits, the tie switch will open and cut the large unit off the original, lighter, bus structure. This was thought necessary, as the interrupting capacity of the original feeder switches was not sufficient to take care of the increased generator capacity under short-circuit conditions. Also, duplicate feeder switches were installed in the new structure for all important circuits, and with the necessary connections and disconnecting switches duplicate bus conditions were obtained.

The switchboard at this station is located over the original bus structure on the same floor as the generator units. This switchboard contains controlling and metering equipment for the generators and feeder circuits, voltage regulators, exciter buses and exciter starting equipment. Provision is also made for excitation of the generators from the d.c. bus, in case of trouble with the exciters. Also controlled from this board, are the tie line switches. These switches are in duplicate on the different structures and are 2300 v., 2500 amp. capacity, and tie plant two motor room buses to the original a.c. low pressure station buses located in plant one. Distance between the stations is about 3,000 feet and the feeders are 1,000,000 c.m. cable per phase. It is possible, with this connection, for either station to help out the other when conditions warrant it. It is also possible, by means of suitable disconnecting switches, to isolate each structure for inspection and repair, when required. Integrating watt hour meters on this tie circuit are equipped with ratchet devices, which allow the meter to register power delivered, but do not show power received. There are also installed, graphic watt meters, with zero center, which enable the operators at all times to check the exchange of power between the stations.

The tie line is in three sections, due to having part of this line installed in a tunnel. At the junction of these sections are mounted special disconnecting switches, located in concrete houses at the foot of the towers. Also at this point are installed two sets of transfer switches which can be thrown to either

side of the main disconnecting switch. This means that feeders on these switches can be connected to plant one or plant two a.c. stations at will. One set of feeders supplies power for two 1,000 k.w. synchronous motor-generator sets, located at plant one, adjacent to mill distribution board. These machines were added to take care of the new shops and other installations made at plant one, and also to take care of the voltage drop on the original d.c. lines from the blast furnace station. The second set of feeders on transfer switches supply current to a 600-h.p. gas booster station, which is operated only over the shut down period at the end of the week when there is an excess of coke plant gas available.

The second section of the switchboard consists of starting and metering equipment for the three synchronous motor-generator sets. Each set has its own feeder switch in the main structure, the starting switches being located back of their respective panels. The feeder switch of each machine is electrically interlocked with the holding of the starting switch operating gear, so that, on the occasion of any disturbance on any unit, the opening of the feeder switch automatically releases the latch on the starting gear. This method of operation was employed due to the fact that the interrupting capacity of the starting switches is not adequate to take care of disturbances that might happen on a machine of this size. By the manipulation of the field current of these motors, power factor from 90 per cent to 95 per cent is obtained on the main bus.

The third section of the switchboard consists of three d.c. generator panels, one d.c. tie line panel, four 4,000 ampere feeder circuits, six 2,000 ampere feeder circuits. Two of the generator panels are equipped with the necessary switches and resistance for reversing the operation of these machines, in case of emergency. The d.c. generator is operated as a d.c. shunt motor, the synchronous motor running as an alternator. Pedestal type switches are located at these machines for shunting out the series fields, as reversal of current in the armature running as a motor would cause the series fields to buck the shunt fields. A scheme of this kind might be all right from an emergency standpoint, but would not be very satisfactory from an operating point of view, as the variation of the d.c. voltage would effect the frequency considerably. The d.c. tie line circuit consists of 4,000 ampere circuit breaker, necessary line switches, volt meter, ammeter and integrating watt hour meter with ratchet attachment. This panel connects plant two d.c. bus with the original d.c. power house bus located at the blast furnaces, and it is possible to exchange 3,000 amperes by adjusting the bus voltage at the different stations. This tie line is also used as an emergency circuit for the open hearth mixer and the rail mill magnets. In case of failure of the voltage on either of these circuits, they are instantly connected to the tie line by means of standard spring closing magnetic switches. The coils of these switches being energized from the department feeders and thereby holding the switch open. Immediately on the failure of voltage, the spring attachment connects the department to the tie line circuit and this scheme of switching operates so rapidly that it is possible to pull the main switch on the rail mill crane magnets handling the rails without dropping the rails.

(To be concluded in March)

Annual Banquet Memorable Occasion

Address of Elisha Lee, Vice President, Central Region, Pennsylvania Railroad, Before Engineers' Society of Western Pennsylvania, Pittsburgh, Pa., Jan. 28, 1924

IT is an unusual pleasure and privilege to be with you tonight, partly because I am myself a member of the engineering profession, and partly because engineers are peculiarly fitted to grasp railroad facts and problems with ready and sympathetic understanding. American railroads, regarded as a national transportation system, constitute probably the finest monument in the world to engineering genius and knowledge, as well as to the foresight and courage of business men, financiers and investors. Indeed, the physical form which our railroad plant takes today is almost wholly the work of engineering brains, chiefly in the civil and mechanical branches, although our specialists in electricity and chemistry may also claim important shares.

The era in which we are living is chiefly distinguished by the marvelous advancements which have

The forty-third annual banquet of the Western Pennsylvania Society will long be remembered by the thousand or more members present at the William Penn Hotel, Monday, January 28. The speakers were brilliant in their eloquence, and their speeches seemed to be the thoughts of an enthusiastic audience.

Not every incoming president can boast of such a welcome as was accorded Prof. Crabtree; not every toastmaster can subordinate his personality to the obvious needs of the occasion as did Mr. Thompson; not every railroad executive will discuss his problem in unequivocal paragraphs as did Mr. Lee, and seldom does a banker assemble the political, economic and social phases of present world conditions in straight from the shoulder discussion, as did Mr. Kent.

President Crabtree in his introduction paid tribute to the retiring president, Morris Knowles, and to George T. Ladd, chairman of the banquet committee, and J. C. Hobbs of the entertainment committee. He emphasized the splendid condition the Society finds itself in, and congratulated the members on the facilities now accessible to them, holding out evident promise of extension to those facilities.

been made, especially during the last 50 years, in the practical applications of science to economic ends. As such, it may be differentiated from all other periods in history as the "Age of Engineering," for engineering may be defined as the utilization of progress in theoretical science to the material improvement of the standards and conditions of human life.

I am exceedingly proud of my membership in this great profession, whose contributions to the betterment of our race have certainly not been excelled, and perhaps have not been equalled, by those of any other

secular calling. And I am especially proud of the fact that ever since my graduation as a civil engineer, 31 years ago, I have had opportunity to apply my technical training to the indispensable public service of railroad transportation.

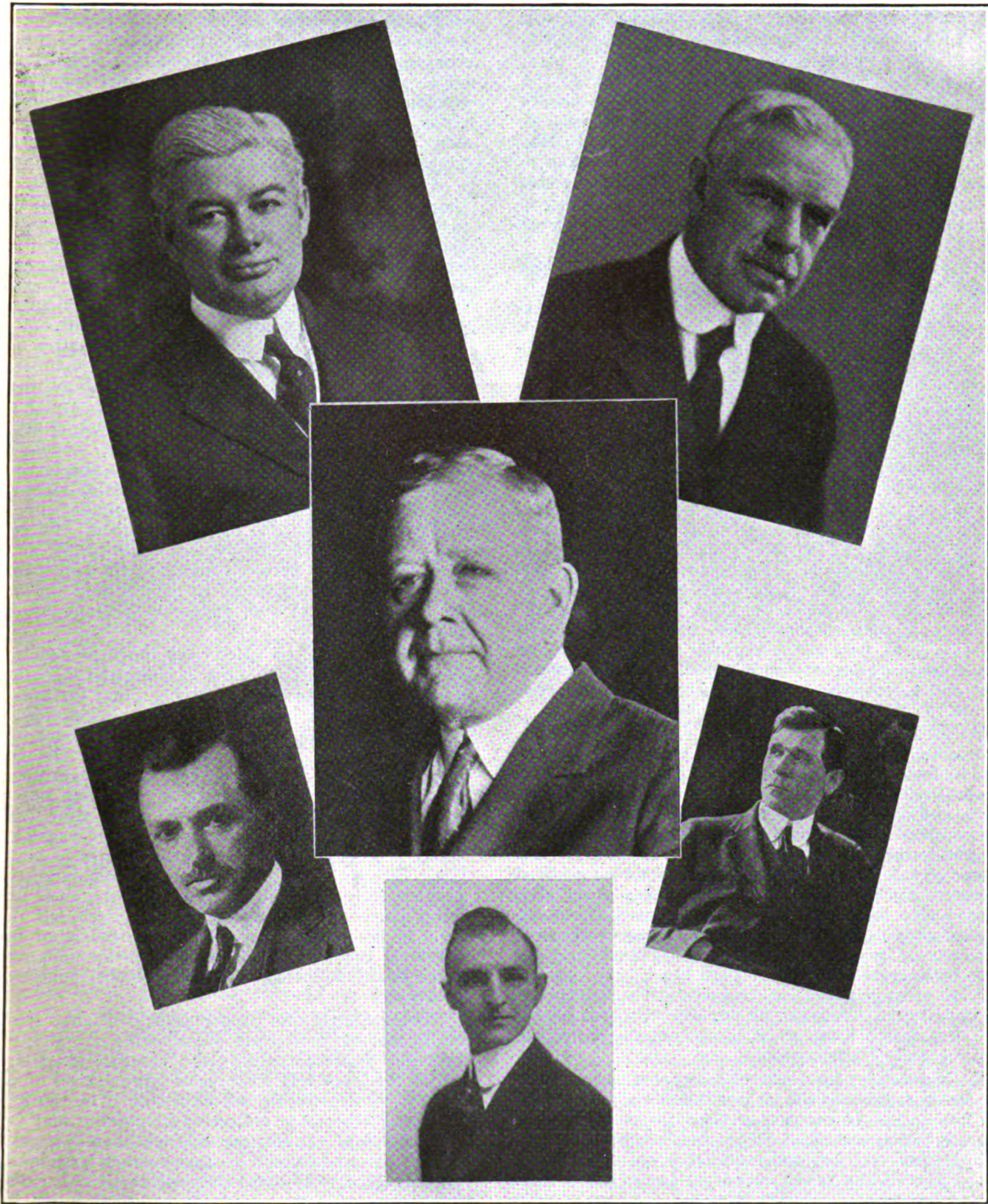
Never before have I felt that pride so keenly as at present. Since the earliest days the railroads have always been splendidly efficient servants of our country. They were the principal physical means by which the interior of the continent was opened to settlement and civilization. Following their emergence from the experimental stage, some 90 years ago, their evolution has paved the way for the development of our immense agricultural wealth, our great cities, our countless factories and mines, and finally for the perfecting of our American system of industrial mass production, which is the real basis upon which our economic world leadership rests.

After passing through a prolonged era of misunderstanding, misrepresentation and political abuse, which we may call the "Dark Ages" of transportation history, our railroads at the present time stand far higher and better in the public estimation than for more than a generation. They have won the public respect and won it fairly. They have been given the cleanest bill of health of any department of American business enterprise, following nearly 40 years of the most searching investigation and microscopic flaw-hunting to which any form of business has ever been subjected in any country.

The American railroad systems, as they stand today, represent an investment in physical facilities of roundly 22 billions of dollars. It may be recalled that in 1920 the Interstate Commerce Commission allowed a tentative valuation for rate-making purposes of \$18,900,000,000, as against a book figure, for property investment, of \$20,040,000,000, at the opening of that year. Since that time at least \$2,300,000,000 more have been expended upon capital improvements. This would bring the present valuation, based on the commission's tentative figure of 1920, up to \$21,200,000,000, and based upon the book figures of the companies, as they stood at the opening of 1920, up to \$22,340,000,000.

Were they to be valued on the basis of present prices of materials, the actual market worth of real estate and the prevailing costs of labor and wages, a figure at least half as great again would inevitably be reached. It is indeed questionable whether our railroad systems could be duplicated today for 35 to 40 billions of dollars.

It may be of interest in connection with this subject of physical valuation and property investment to turn for a moment to the annual payroll of our American railroads, which we may perhaps find it useful to regard as a continuing investment in the loyalty, fidelity, devotion and enthusiasm of an immense working force. The \$22,000,000,000 physical plant of American railroads has been nearly a century in the making, representing an investment of considerably less than



A. W. THOMPSON

F. I. KENT

ELISHA LEE

K. F. TRESCHOW

FREDERICK CRABTREE

STRICKLAND GILLILAN

\$240,000,000 for each year of growth. But last year the employes of these railroads received \$3,000,000,000 in wages. In other words, in about the next six years, allowing for the probable increase in forces, the railroads of the United States will make an investment in payroll that will duplicate the investment in plant which has had 90-odd years to pile up. So we can see that it is really a matter of nationwide concern that this vast payroll investment in human services and loyalty, which is growing at the rate of \$10,000,000 or more a day, should be made with wisdom in order to produce the vastly beneficial results which are capable of realization under intelligent and sympathetic relationships between railroad managements and railroad working forces.

This brings me to the point where I wish to say something in regard to the relation of the engineer to labor problems. The engineer in our present industrial system generally occupies a leading position in what we commonly refer to as "management." He is entrusted with the determination of policies for successfully guiding and directing the work of large numbers of men. He is in turn responsible for creating and maintaining an output satisfactory as to quantity, quality and cost per unit, and in the case of public utilities, for continuity and safety of operation.

Necessarily, these responsibilities include the building up and holding together of a working force, adequate, but not excessive, in numbers, loyal and willing in spirit, and capable of maintaining a satisfactory rate of production. This means that the engineer must not only devise labor and operating policies which are sound on paper, but must convince his working forces of their reasonableness and fairness. From this viewpoint, part of the engineer's equipment is, or should be, an adequate understanding of human nature, and a real knowledge of the causes which contribute to labor unrest or contentment.

At present, and for some time back, the engineer, confronted with the problems I have endeavored to sketch, has been obliged to cope with practically a universal demand for lower unit costs. The people want, and in some cases are insistently demanding, lower prices for manufactured articles and commodities and lower rates for service. It is hardly necessary for me to say that this expectation cannot be realized unless we can find some means of effecting lower labor costs, and I may say that as matters now stand, increased output per man, either by greater personal efficiency or by engineering aid, holds much brighter hope for increased efficiency than lies in any possible revision of wage scales. Such increased output means no impairment whatever of our American standards of living, which I am proud to say are the highest of all time and of any nation.

This necessity for lessened labor costs arises from the fact that labor is the largest individual item entering into costs. In the case of the railroads, their own payrolls constitute about 50 per cent of the total costs of operation, and fuel and material costs, which make up nearly all the other expenses, are in themselves largely wages paid to other workers. The main problem in reducing costs, whether of products or service, lies, therefore, in obtaining the co-operation of labor.

This problem lies chiefly in strengthening the sense of loyalty on the part of the individual worker to his job and to the enterprise by which he gains his livelihood. This problem with the railroad is largely an inheritance from the period of government opera-

tion. It is associated with the policy of adjusting wages and working conditions for war purposes and political ends which largely prevailed during that era. It also reflects other policies of government control which resulted in forcing large bodies of railroad workers under the sway of those labor organizations which practice or countenance the uneconomical and indefensible principles of the sympathetic strike, limitation of output and the closed shop. In this connection I might say that these principles are not countenanced by the four big transportation brotherhoods.

While, according to historians, strikes and other concerted labor movements to obtain more satisfactory working arrangements were not unusual, from about 2000 B.C. up to modern times in the old country, in our own country the condition of labor unrest did not assume definite form until the early part of the nineteenth century, and was of no particular importance in our economic life until about the outbreak of the Civil War. Since that time the matter of unrest among laboring men has grown in a manner corresponding rather closely to the growth of the so-called factory system of industry, where capital, management and labor are rather distinct individual groups.

It will be recalled that, up to about the beginning of the nineteenth century, industrial plants were small and the owner was not only the capitalist, but also manager and often one of the workmen. Therefore, these conditions of employment constituting an intimate relationship between management and men, deserve serious consideration in determining the policy for the handling of men under our present industrial system.

I feel that we are often very much misled by the expressed demands involved in concerted labor movements, rather than the underlying cause for these demands. It is, for instance, a rather popular idea that the predominating cause of strikes is a desire for increased wages. As a matter of fact, the element of wages is, certainly, in a very large percentage of strikes, only injected after the organization has been completed and functioning for some time. Many strikes are called without any mention of wages at all. There is a deeper cause than either wages or hours of labor, or even many of the demands calculated to improve working conditions. I believe the chief underlying cause of labor unrest making itself felt in the form of labor unions or other concerted labor movements is the human desire to have an unoppressed voice in all deliberations where labor policies are involved.

These human and proper desires of labor are generally met by some form of collective bargaining. It probably represents the only practicable basis by which the labor relationships of large masses of workers can be dealt with and adjusted. The thing is to distinguish between collective bargaining and collective coercion. Unfortunately, we have a good deal of the latter; so much so that certain large and important groups of workers outside of the railroads have been able to retain, in practical entirety, the highest inflated wage scales which prevailed during the war. We must cure that condition by a process of education, and by directing the pressure of public opinion against the attitude of those groups of workers who persist in substituting coercion for bargaining in their collective relations with society. There have been many experiments evolved to meet this situ-

ation in the form of working arrangements commonly referred to as "employee representation." We have one form on our railroad. Many of you have heard of it, and I will not attempt to explain its details. Essentially it is a system of collective bargaining within our own ranks—a plan by which our officers and men get together face to face to avoid or settle, in peaceful conference, difficulties which may arise respecting wages, discipline, working conditions and similar matters.

It recognizes the right of the worker to a voice in determining questions affecting his own conditions of employment. It not only recognizes the general principles of collective bargaining, but is in itself a working system of collective bargaining, which simply means dealing through chosen representatives instead of individually with each employee. It seeks to avoid controversies and to assure employment, at a fair pay. It is in no sense anti-union, the truth of which statement is evident from the fact that in many cases the representatives elected under it continue to hold their union affiliations. No man on the Pennsylvania railroad holds or loses a job because of union affiliation or non-affiliation. The plan may not be perfect as yet, but has the support of an overwhelming majority of our employees expressed in the results of elections held under secret ballot.

We have found that the elected representatives when placed on their responsibilities as judges with same individual voting power as the management have proved themselves honest, thoughtful and practical and are taking greater interest in and helping to solve some of the problems of management. It is working with greater success every day, because, as we believe, it is based upon fundamentally sound principles. Some time we hope to see the power and influence of the government exerted toward helping instead of hindering the functioning of this obviously American plan of settling differences peacefully and by mutual conference. A vast forward impetus would thereby be given to restoring and further strengthening the feeling of loyalty on the part of railroad workers, not only on the Pennsylvania, but on other lines as well. These are some of the problems that engineers must continue to study, for none is of more importance today than those of human relations in industry. That a proper solution will be worked out to fit the varying cases I have no doubt.

To an audience of engineers it would be superfluous to demonstrate the indispensable character of the public services which our railroad systems render. The pursuit of almost any branch of our profession will bring fresh proofs of that truth daily. I may say that the business men of the country are also alive to the necessity for good and progressive railroads, and I believe the vast majority of intelligent and progressive farmers also.

Our railroads are more open to the scrutiny of the public today than any other form of business. They have no secrets any longer. I do admit that they have some grave problems which will require courage and intelligence to face and solve. But I am happy to count myself among those who view the outcome hopefully and with sober confidence. My reasons are very simple. The railroads are indispensable to the country. Continued national progress is impossible unless they are allowed to grow and prosper. These facts are better known than ever before and are gain-

ing a wider recognition every day. I have great respect for the common sense of my fellow citizens and refuse to believe that, in the light of their broader knowledge, they will indefinitely keep on permitting such invaluable national assets as our railroads to be misused for political ends or despoiled for narrow and selfish motives. Hence, I look for a better deal at the hands of politics and for continued improvement in the character and purposes of public regulation. It is possible for regulation to be a splendidly helpful and constructive force. I believe it is in process of so developing and will reach the goal.

Just a brief reminder of the excellent performance of the American railroads in the past eight or nine months, during which time they placed their road and equipment in good condition, and carried a record-breaking traffic practically without embargo or car shortage. This has been accomplished by the managements with the co-operation of the employees and the shippers. I heartily congratulate the railroad profession as a whole for the loyalty and improved efficiency of the employees during the year 1923, and for their steadfastness to the public service in avoiding strikes. These results should be convincing evidence that if railroad managements are allowed greater freedom to promptly deal with all problems, including those of rates and wages, and are freed from further restrictive laws and vexatious and useless inquiries, which waste time, money and effort that could be better spent on the problems of management, they can produce a transportation service equal to the demands of the American people.

TRADE PUBLICATION

The new 72-page catalog issued by the De Laval Steam Turbine Company, Trenton, N. J., exhibits the marked development which has occurred in the improvement of centrifugal pumps, as well as in the direction of larger size and wider use. The rapid extension of the field of the centrifugal pump has been in large part due to improved efficiency, simplicity and ease of maintenance. The casings are split horizontally so that internal parts are at once accessible upon lifting the cover. De Laval pumps are stated to be manufactured to limit gages, assuring interchangeability, so that renewals can be inserted by unskilled men, as they do not require to be fitted and no adjustments of any kind are required. Centrifugal pumps driven by steam turbine or electric motor are used almost exclusively for circulating condenser water and are also extensively applied for feeding boilers at the highest pressures. In water works service, centrifugal pumps driven by geared steam turbines are built in sizes up to 5,000 water horsepower and over, and realize duties closely paralleling those of the best triple expansion crank and fly wheel pumps. The aggregate daily capacity of water works units built by the De Laval Company alone exceeds four billion gallons. Large electric motor driven pumping units show efficiencies from wire to water exceeding 80 per cent, the pumps themselves developing efficiencies as high as 87.2 per cent. Centrifugal pumps are widely used for fire protection and may be driven by electric motor, steam turbine or gasoline engine. Gasoline driven pumps are often provided as stand-bys to motor driven pumps. In the industries centrifugal pumps are used extensively not only for general water service, but also for handling water containing solids in suspension, such as paper pulp or rags, and for pumping chemicals.

Reduction of Iron Ore in the Blast Furnace¹

Close Agreement Between Calculated and Observed Values
Indicates the Validity of Conclusions Drawn

By P. H. ROYSTER², T. L. JOSEPH³ and S. P. KINNEY⁴

PART I, SECTION 2

Introduction.

IN the first part of this paper⁵ was shown the dimensions of the experimental furnace of the Bureau of Mines at Minneapolis, while the charge and analysis thereof, and the general operating conditions were described. The accompanying half-tone is from a photograph of the furnace.

The calculated yield of metal from each round was 82.6 pounds of pig iron, and by analysis the metal was found to average 3.5 per cent carbon, 1.25 per cent silicon, and 0.04 to 0.1 per cent sulphur. The metal was sand cast and showed a gray fracture. Casts were generally made every two hours, but as the make of metal (230 pounds per hour) was rather small, and because each inch of hearth depth held 100 pounds of metal, accurate weighing of the product was not attained. Since, however, (1) the stockline moved with great regularity; (2) the flue dust was too small to be measured, because of the absence of fines; and (3), the slag analysis showed less than 1 per cent of iron, it was not necessary to obtain any special accuracy in cast-house weighing.

The average analysis of the top gas when operating steadily under the above burden was as follows:

Constituent	Per Cent
CO ₂	10.17
CO	24.93
H ₂	1.31
N ₂	63.59

The samples of gas were taken under mercury by the method described by Perrott and Kinney⁶. The analyses were made by L. B. Berger of the Bureau's Pittsburgh Experiment Station, and by one of the writers. There is a possibility that the above average analysis is in error due to the difficulty in getting representative samples, since the gas composition varied with time. Another difficulty arises from not knowing in just what manner to combine a number of analyses to give a representative figure. As far as purely analytical errors are concerned, it is unlikely that a systematic error greater than 0.2 per cent should exist.

Calculations of Top Gas Analyses.

If the weights and analysis of a charge are known even with accuracy, it is not possible to predict the

¹Published by permission of the Director, U. S. Bureau of Mines. (In the January issue a typographical error changed "Reduction" to "Production".)

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⁵Blast Furnace and Steel Plant, vol. 12, Jan. 1924, pp. 35-37.

⁶G. St. J. Perrott and S. P. Kinney, Combustion of coke in the blast-furnace hearth; Trans. A. I. M. & M. E., vol. 69, 1923, p. 526; and abstracted in *Mining and Metallurgy*, vol. 4, 1923, p. 145.

analysis of blast-furnace gas except under certain definite conditions, and unfortunately these conditions appear never to obtain in industrial practice. It is of course possible to agree with Johnson⁷ that the calculation of gas composition is not a problem in chemistry at all, but only a rudimentary one in arithmetic; but we must immediately qualify this statement, as he did, by specifying, (1) that there shall be no "solution loss," "carbon absorption," or "premature combustion" taking place; (2) that no water shall be leaking into the furnace; (3) that no "direct reduction" of iron oxide shall occur; and (4) that there shall be no deposition of carbon. According to Sperr and Jacobsen⁸, however, these so-called secondary reactions do take place in actual practice, and to the extent of some 20 to 40 per cent; so it would seem then that the exceptions outweigh the rule.

Fortunately, so far as the nitrogen is concerned, this is not true. The reduction of iron oxide by bosh gas effects merely an exchange, a certain volume of CO disappearing and the same volume of CO₂ taking its place. Neither the volume of the gas nor its nitrogen content is altered by the reaction. If, however, any of the above variously described secondary reactions take place, oxygen from some source other than air enters the gas stream unaccompanied by nitrogen, diluting the nitrogen and lowering its value. There are always present a number of smaller factors which hold the nitrogen content below theoretical bosh-gas composition, such as moisture in the blast, silicon reduction, hydrogen from the coke, CO₂ from the flux, and the formation of calcium sulphide. Simple arithmetic will usually predict about 62 or 63 per cent nitrogen.

In regular blast-furnace operation the nitrogen is generally much lower than this, the values usually encountered in American furnace practice varying from 54 to 59 per cent. This relative deficiency of nitrogen proves a ready means of ascertaining the extent of the secondary reactions taking place in the furnace.

Blast-Furnace Gas from the Experimental Furnace.

The gas analysis recorded above indicates that "direct reduction" was apparently absent in the furnace operation described, so it may be of interest to compare this observed analysis with the analysis calculated by simple arithmetic.

A round of coke contains 96.7 pounds of carbon (120 lb. x 80.6 per cent). The metal takes up 2.9 pounds of this as carbide. The silicon and sulphur reactions in the hearth consume another 1.2 pounds and generate 2.9 pounds of CO. This leaves 92.6 pounds

⁷Johnson, J. E., Principles, operation, and products of the blast furnace, 1918, p. 13; (McGraw-Hill, New York).

⁸Sperr, F. W., and Jacobsen, D. L., Physical properties of coke; *Blast Furnace and Steel Plant*, vol. 11, June, July, Aug., 1923.

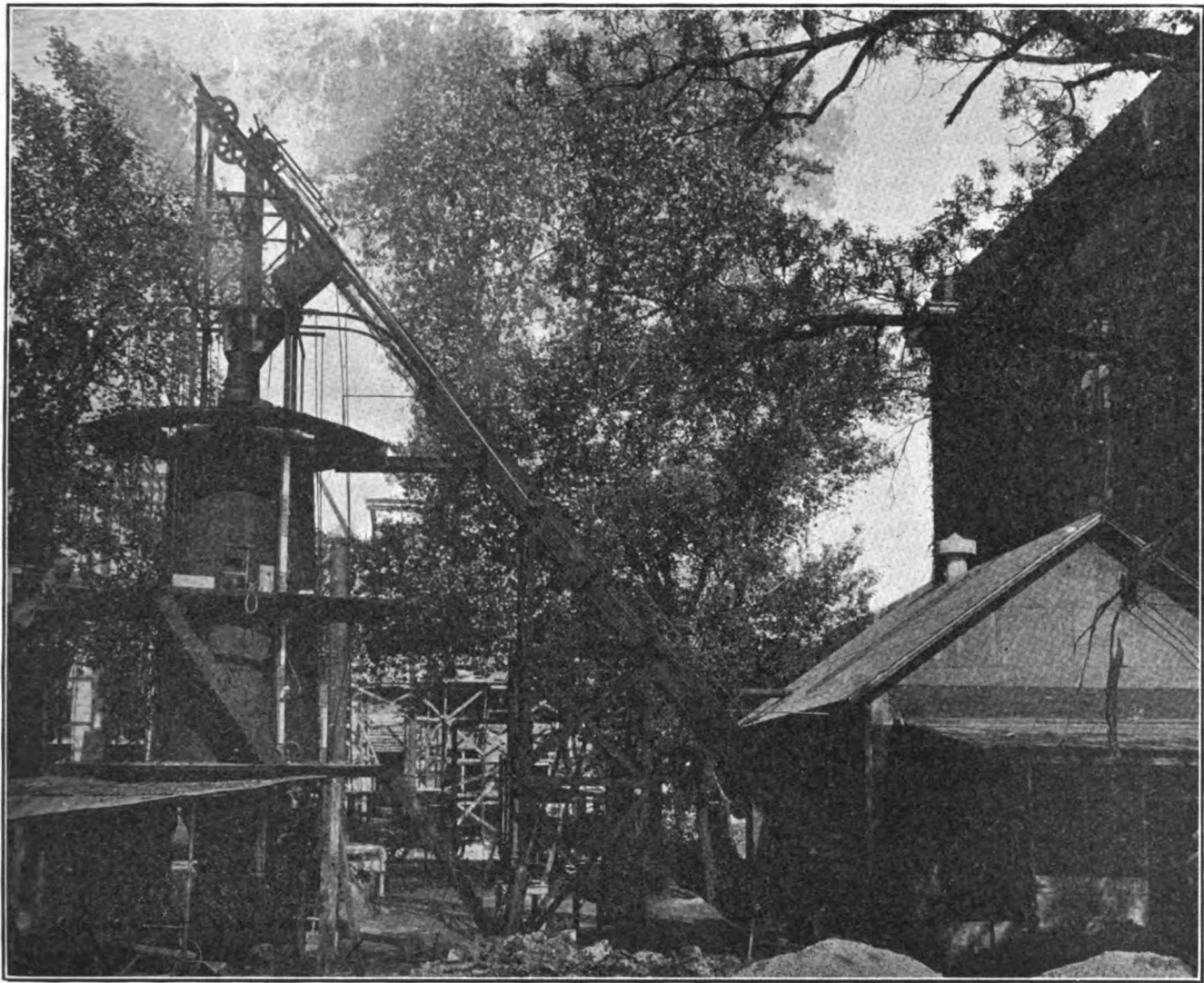


FIG. 3—View of experimental blast furnace from which practical operating data was secured by the Bureau of Mines.

of carbon to be burned by the blast. It requires 527.1 pounds of moist air (under the conditions prevailing at the time) to burn the carbon, which corresponds to 524.5 pounds of dry air and 2.56 pounds of water. The air contains 6.76 pounds of argon, 397.23 pounds of nitrogen, and 0.286 pound of hydrogen. The oxygen in the mixture (dry air plus moisture) combines with the carbon to produce 218.93 pounds of CO in the bosh.

The ore in each round contains 75.6 pounds of iron (145 lb. x 52.1 per cent), and the limestone 0.4 pound, both as ferric oxide, and combined therefore with 32.61 pounds of oxygen. The hydrogen in the gas stream is small, but it is a strong reducing agent, and undoubtedly reduces some ore. The observed value of hydrogen is used here to calculate the extent of hydrogen reduction, although its effect one way or the other is small. Of the total (0.93 pounds of hydrogen present in the gas stream 0.29 pound from the blast and 0.64 pound from the coke), it appears that 0.32 pound is used for reduction. This takes care of 0.79 pound of the oxygen in the ore, while another 0.11 pound of oxygen is carried away as ferrous oxide in the slag. There is left 29.96 pounds of oxygen for CO reduction. The removal of this much oxygen from iron oxide causes 52.43 pounds of CO to be converted

into 82.39 pounds of CO₂. The flux adds 20.58 pounds of CO₂ per round to the gas stream, and the coke gives off 1.01 pounds of nitrogen.

The components of the top gas in pounds per round may therefore be summed as follows:

Constituent			Weight of gas	
CO ₂	82.39	+	20.58	= 102.97
CO	218.93	—	52.43	= 166.56
H ₂	0.93	—	0.22	= 0.61
N ₂	397.23	+	1.01	= 398.24
A				6.76
Total				675.14

Using the densities of gas as given by Blanchard⁹ the analysis of the gas by volume is readily calculated to be as follows:

Constituent	Calculated, %	Observed, %
CO ₂	10.13	10.17
CO	25.89	24.93
H ₂	1.31	1.31
N ₂	62.67*	63.59

*Argon is, of course, reported as nitrogen in analysis.

The agreement here between calculated and observed values of the gas composition is probably as

⁹Blanchard, M. S., Densities of important industrial gases—a review: *Chem. & Met. Eng.*, vol. 29, 1923, pp. 399-400.

good as would be expected from the conditions under which the furnace was operated. The realization in the actual test of accurate weighing, of homogeneity of materials, and of regularity in operation is more difficult than might appear at a glance. The outstanding feature of the comparison is the fact that the observed nitrogen exceeds the predicted nitrogen, a result just the reverse of that found in all the previous records the writers have examined. As already pointed out, the existence of solution loss and direct reduction would give an observed nitrogen content lower than that calculated. There is therefore no experimental evidence pointing to the existence of any such reactions.

Carbon Burned at the Tuyeres.

The significance of these data may also be studied from the standpoint of the fraction of the total carbon charged that reaches the tuyeres and is available for combustion there. According to Howland¹⁰ this amounts to an average of 78.2 per cent for the 26 furnaces he has examined. Perrott and Kinney¹¹ find a mean value of only 76.1 per cent, although five of the nine furnaces included were Southern furnaces carrying a low iron-oxide burden. Two of the writers collected data in 1919 from 20 furnaces, none of which was examined by Howland or by Perrott and Kinney, and the fraction of fixed carbon charged which was burned by the blast (moisture excluded) was found to average 78.0 per cent. The average of the 55 furnaces from these three sources, which are representative of present-day American furnace practice, gives 77.8 per cent.

In the operation of the Bureau's experimental furnace discussed above, the air of the blast oxidized 90.9 pounds of carbon per round, and 96.7 pounds of carbon was charged per round—that is, 93.9 per cent of the fixed carbon of the coke reached the tuyeres and acted as furnace fuel, a loss of 6.1 per cent. This fuel loss, moreover, was largely due to carburizing the metal, reducing silicon, and removing sulphur from the metal—or keeping it out. Carbon consumed thus can not fairly be thought of as fuel loss, since a merchantable grade of pig iron was the primary object of the furnace operation. The corresponding figure for fuel loss in industrial practice (22.2 per cent) is nearly four times as great, and indicates a difference between the two practices.

Nitrogen in the Gas.

It is possible, in a most direct way, to prove this difference by considering the volume percentage of nitrogen in the furnace gases. The average nitrogen content of the top gas from 55 American furnaces quoted above is 57.66 per cent¹². This is 5.93 per cent less nitrogen than the 63.59 per cent found in the operation of the Bureau's furnace. Six per cent difference in nitrogen cannot be easily explained except by the assumption already made in this paper, that the iron oxide in the Bureau's furnace was reduced by CO, and reduction by solid carbon did not take place.

¹⁰Howland, H. P., Calculations with reference to the use of carbon in modern American blast furnaces; Trans. Amer. Inst. Min. Eng., vol. 56, 1917, p. 339.

¹¹G. St. J. Perrott and S. P. Kinney, work cited.

¹²Howland's 26 furnaces give 57.78 per cent; Perrott and Kinney find 56.82 per cent for 9 furnaces; while Royster and Joseph find 57.91 per cent for 20 furnaces.

¹³Bell, I. Lowthian, Chemical phenomena of iron smelting, 1872.

Conclusion.

In view of the experimental data recorded here, the theory of Bell¹³ that CO cannot completely reduce iron oxide seems untenable. It was pointed out that this theory has no scientific basis. It has also no experimental verification, unless one wishes to attribute the failure of CO in general practice to reduce all the iron oxide to its inherent limitation as a reducing agent. There are many reasons easily given why CO does not complete the reduction process in present-day furnace practice, and the most probable cause is this: The ascending gas stream does not come in contact with each individual particle of ore at a proper temperature at the correct velocity and composition, or for a suitable length of time. The wide acceptance of Bell's theorem among furnace designers and operators may be to some extent responsible for this condition, for if they assume from the start that 100 per cent reduction by CO is chemically impossible, they will neither design the furnace nor operate it to attain complete reduction. The fact that the Bureau of Mines, handicapped by a small furnace, has apparently been able to produce pig iron of merchantable quality from iron ore without causing any direct reduction or solution loss to take place, should make the problem of attaining the same results on the more easily worked industrial furnace seem more promising.



Heads Nation's Engineers

Former Governor James Hartness of Vermont, who has just been elected president of the American Engineering Council. As the successor of Herbert Hoover and Mortimer E. Cooley he will direct a nationwide movement for the establishment of a national Department of Public Works. The engineers will also co-operate with the U. S. Forest Service and other state and Federal agencies in a campaign to save the country's dwindling forest reserves.

Dry Cleaning Blast Furnace Gas By Filtration Through Flue Dust

Careful Tests and Investigation of Conditions at Each Individual Blast Furnace Necessary In Determining Area of Dry Cleaner

By GEORGE B. CRAMP

THE basic principle of this method of gas cleaning being the use of flue dust as the medium for cleaning the gas from which the dust is precipitated, and although the use of flue dust for this purpose has the advantages of being immediately available, costless, and readily renewable without mechanically handling; there is nevertheless entailed in the application of this principle of cleaning, the necessity of extreme care in determining the gas permeability of the available dust at each individual blast furnace before it is possible, intelligently, to arrive at the area of cleaning surface required for cleaning the gas from that furnace, as well as certain other important details of the dry cleaner.

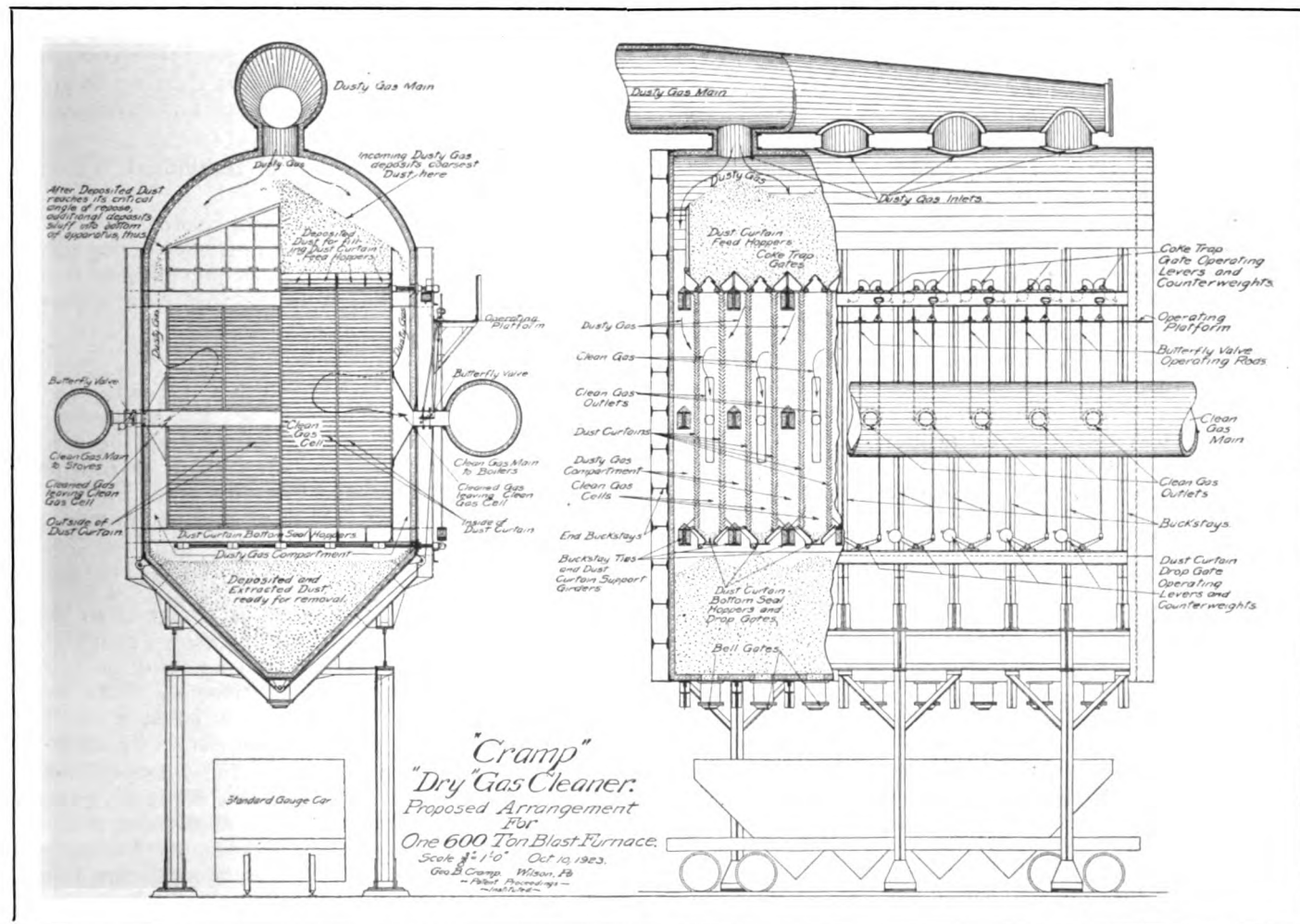
Determining Conditions.

The various conditions prevailing at each furnace that will require investigation and influence the results of tests are:

1. Fineness or texture of flue dust.
2. Temperature of gas.
3. Presence of large particles.
4. Tendency to adhesion.
5. Proposed or convenient location of dry cleaner.
6. Volume of gas to be cleaned.

Fineness of dust more than any other condition will predetermine the results obtained in tests to determine its permeability to gas passage through it, and the coarser the flue dust that is produced at a furnace, the greater its permeability and the less cleaning area that will be necessary to provide.

Temperature of gas from each individual furnace will influence to a great extent, the angle of repose of flue dust as it is precipitated in the various apparatus and gas mains designed to receive it, and which dust would be used as the filtering medium in the Dust Cur-



tain Grids shown in detail in Fig. 2. The hotter the gas from the blast furnace, the more fluid like in its action the dust seems to become and the less, or more nearly level, becomes its angle of repose. If the gas temperature is uniformly low, the dust may be taken at a maximum point and its angle of repose determined at this temperature by a simple gauge.

The resultant angle of repose under these conditions will influence the design of the louvers forming the dust curtain grids, the upper edges of which must be kept, as nearly as possible, at the foot of each dust heap formed by each louver, but not so close to the critical angle or overflow point that dust will, under the hottest temperature, begin to spill or flow over the upper edges of the louvers. It is just important that the upper edges of these louvers are not raised too high above the foot of each dust heap as this will form a pocket into which a layer of very fine dust will settle, instead of sluffing off the dust heaps as intended it should do. Such layers of fine dust on each dust heap will naturally compel the maintenance of a lower gas velocity and the passage of less gas through a given area of curtain per unit of time.

Presence of large particles in the dust that will remain on a 1/8-inch mesh screen or larger is naturally to be avoided. If there is much stock of this size carried beyond the dust catcher special provision must be made in the design of the dry cleaner to prevent such particles from obstructing free course of filter dust through the dust curtain grids.

Tendency of the dust to cable, pack or adhere to the grid surfaces must also be carefully observed. There will be no marked tendency of the flue dust to do this under ordinary conditions, but if under certain conditions this is observed to occur positive means for cleaning the grids must be provided in the design of the cleaner.

Proposed location of a dry cleaner working under this principle cannot be intelligently advised until the nature and quantity of the dust deposited beyond the dust catcher of a blast furnace is first determined. If the existing dust catcher is of large size, much of the dust will be deposited therein. It may be necessary where this condition exists, to advise the installation of a smaller dust catcher so that gas velocity through it being increased, more and larger particles of the dust will be carried through and beyond it into the dry cleaner. This arrangement might, at some individual furnaces, accomplish a considerable reduction of the cleaning area requisite in the dry cleaner to be installed.

Volume of gas produced at an individual furnace must be closely approximated, or actually measured before the area of the proposed dry cleaner may be calculated. After determining the volume of gas to be cleaned, with a sample of dust as produced at the proposed location of the dry cleaner filling the dust curtain grids of an experimental cleaner it is possible to determine the amount of gas, as produced at the blast furnace, that may, at a safe velocity, be passed through the one square foot of dust curtain within

the experimental device; the amount of gas thus passed may be approximated from size of outlet and existing pressure, or actually metered. With the amount of gas it is possible to clean per square foot of cleaning area being known, the total cleaning area of the dry cleaner may be arrived at.

Though dust content of the gas that is cleaned by this method need not be ascertained beforehand, it

AT FURNACE "A"—50 LB. SAMPLE OF DUST

Number of screen meshes per inch	20	40	60	80	100	Through 100
Weight of dust remaining on screen—Lbs.	5/8	3 13-16	8 3-16	8 1-16	12 1/2	16 13-16
Per cent of total weight..	1 1/4	7 5/8	16 3/8	16 1/8	25	33 5/8

Note—Not over 42 per cent of the aggregate remains on a No. 80 screen or coarser.

AT FURNACE "B"—50 LB. SAMPLE OF DUST

Number of screen meshes per inch	20	40	60	80	100	Through 100
Weight of dust remaining on screen—Lbs.	1/2	4 1/4	19 1-16	6 3/4	4 5/8	14 11-16
Per cent of total weight..	1	8 1/2	38	13 1/2	9 2-3	29 1-3

Note—60 per cent of the aggregate remains on a No. 80 screen or coarser.

will nevertheless be predetermined by the foregoing conditions, but mainly by the fineness of the dust that will be used as the filtering medium. Calculation of the dust content of gas after having passed through the dust curtain of the experimental cleaner may be made however, by passing the gas through the usual paper filter used in laboratory gas tests of this nature, the gas thus filtered being metered, the dust content per cubic foot of cleaned gas may in this manner be determined.

Difference in Dust Conditions at Individual Furnaces.

That there is a wide difference in dusts produced at different furnaces will appear in the following tables which show sieve tests of dust as precipitated in the dust catchers of two blast furnaces located at different plants.

Comparative Gas Permeability.

Dust from furnace A showed in a test with the experimental device to determine its permeability, that 15 cubic feet of gas per minute could be passed through one square foot of dust curtain of 72 square inches effective dust area, while dust from Furnace B will pass about 3 cubic feet more gas per minute per square foot of cleaning area.

Contract of Cleaning Areas.

If a dry gas cleaner was to be designed to clean the gas for each of these blast furnaces, roughly 20 per cent less cleaning area would be required in the cleaner for Furnace B than for furnace A. This, however, is without any consideration being given the sizes of the furnaces or the gas produced by each.

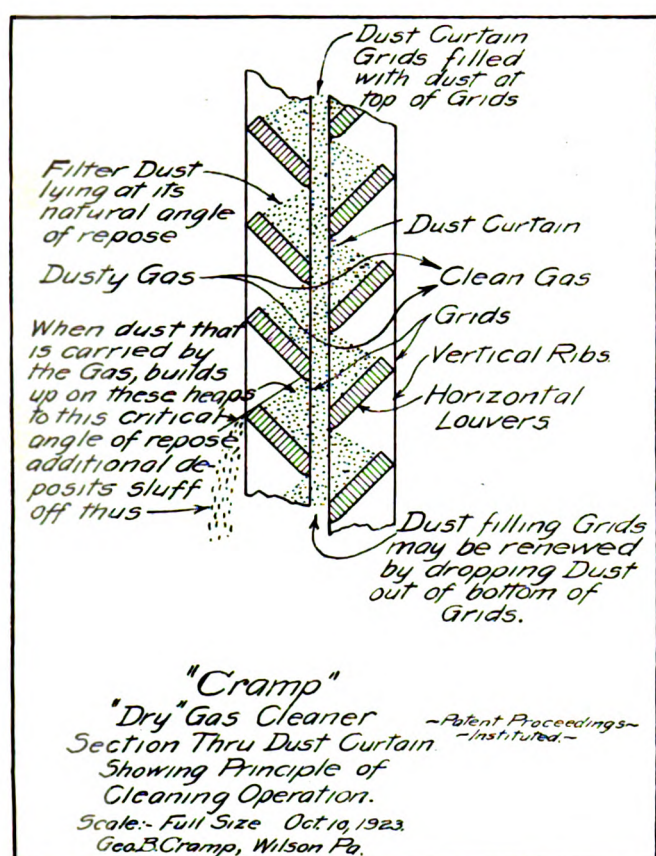
Blast furnace A being a 600 ton furnace, and B a 500 ton furnace, at the rate of 150,000 cu. ft. gas per ton of pig iron A produces roughly 63,000 and B 53,000 cu. ft. of gas per minute. The rate of cleaning per sq. ft. of dust curtain per minute being 15 cu. ft. for furnace A and 18 cu. ft. for furnace B, the area within cleaner A would be 63,000 cu. ft. gas per min, = 4180

cut. ft. 15 cut. ft. gas cleaned per min. cleaning area, and for cleaner B there would be 53,000 cu. ft. gas per min. = 2920 sq. ft. 18 cu. ft. gas cleaned per min. cleaning area.

From these figures it will be observed that at least two of the above named conditions existing at the individual blast furnace, namely texture of dust and volume of gas to the cleaned,—will decidedly influence calculation of requisite area of any dry cleaner.

Comparative Cleanings Efficiency of the Cleaners.

The cleanness of the gas passing through either of the cleaners above outlined will not vary materially, as the velocity through the coarser dust will be slightly higher than that through the finer aggregate, it will follow that the dust content of the gas being filtered through the coarser aggregate will be slightly



higher than that of the finer dust, but as the gas cleaned by either aggregate will not run much in excess of .10 grain of dust per cubic foot of gas cleaned this condition is not one for serious consideration.

Other Considerations.

Probably the most serious question that may be raised as to the practicability of this principle of dry cleaning gas, is the liability of the dust curtain being blown when a heavy slip of the furnace occurs, but this may be readily explained when it is considered that rise in pressure within the dry cleaner does not result in increased velocity of gas through the dust curtain and while this velocity does not exceed a safe maximum for the grade of dust used as the filtering medium, the dust will never be blown from the grids.

Wastefulness of High Ash in Coal

By R. H. SWEETSER*

In September, 1918, all the pig iron manufacturers of the United States were summoned to Washington to appear before the Director of Steel, Mr. J. Leonard Replogle, and make a report regarding the reasons why, if any, they had not produced the amount of pig iron which the Government had a right to expect from them according to their rated capacity, and under the stress of the great World War.

On September 23, 1918, there were gathered together more representatives of the blast furnaces of the United States than were ever together in one room in the memory of those present. At the opening session, Steel Director Replogle, with his winning smile, called for reports from all the blast furnaces in alphabetical order. It was one of the most interesting meetings I ever attended in my life. It was a gathering of men who were straining every force available to produce the amount of iron necessary to furnish the steel and the casting and the sheets and all other iron and steel products necessary for "winning the war."

As each man there responded to the roll call he was either asked why his furnace had not produced the full quota, or else (this was in very few cases) he was commended for producing as much as the Government rating called for. The two great causes of failure to produce the full rated capacity of the furnace was shortage of labor or coke troubles.

In going over the notes I took on the two days of the meeting I find remarks like the following:

"High ash coke."

"Coke troubles."

"Trouble is coke."

"Our production is off 15 per cent on account of poor dirty coke."

"We are running one-third coke, one-third breeze and one-third ashes and breeze."

"Our coke is 20 per cent ash and 1¼ per cent sulphur."

"We can't get coal for our coke ovens."

"There is too much dirt in our coke and the ash is averaging 15 per cent."

Last January the average ash in the coke was 16.60 per cent. It has been high as 17.60 per cent for a whole month."

"The ash in our coke runs from 13 per cent to 17 per cent and the quality is not good on account of delays in drawing the beehive ovens."

"The coke has fallen off from 10 to 15 per cent in quality."

"The shortage of our product is due to the quality of the coke. The ash is 17 per cent and the sulphur is from 1.60 to 1.90 per cent. We produced only 5,500 tons and should have made 7,600 tons."

One man said that he was using 2,700 to 3,300 lbs. of coke per ton of pig iron because the quality was bad.

When it came my turn to report for the blast furnaces at Columbus, Mr. Replogle said: "Your rating is 16,000 tons. You made 14,400." I explained that high ash in the coke cut down the tonnage and when

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(Continued on Page 106)

The Present Situation in Germany

Quantity Rather Than Quality Production Results from Ruhr Dislocation

By HUBERT HERMANN*

AS regards production, the iron and steel industry in Germany has shown a similar development to that in America, but, of course, without reaching the American figures by a long way. In 1913 the German pig iron production amounted to roughly 19,000,000 tons, the steel production to 18,900,000 tons, and was thus by far the largest of all iron producing countries in Europe. English and French production was left far behind. How fundamentally conditions in Germany have changed, if only production is considered, the following table will show:

	Pig Iron Production Tons	Steel Production Tons
1916.....	13,284,738	16,182,520
1919.....	10,807,494	13,756,873
1920.....	5,554,472	6,733,032
1922.....	6,500,000	9,000,000

This drop in production has been caused directly and indirectly by the after effects of the war. Directly by the loss of important iron works, indirectly by the economical, political and social upheaval frequently called a "revolution," being, as a matter of fact, not a revolution in the sense of the previous great political changes known to history, but rather a kind of spiritual breakdown of a very efficient people grown weary through colossal deprivations during a long war but of an active spirit that has been proved by the working up of a leading iron industry in the course of a few decades.

The root cause of the debacle is partly the old rivalry between France and Germany that has existed for centuries and that, owing to the outcome of the 1870-71 war, had to be paid for by the French by the loss of Alsace-Lorraine that once before had been German. However, this loss in 1871 was by no means equivalent with an important economical loss for the French because the industrial importance of Alsace-Lorraine at that time was still small. The deposits of iron ore in Lorraine, although known in 1871, could not be worked to advantage because, owing to the high phosphorous content, the ores could not be transformed into steel. It was not before 1878 when, through the invention of Thomas, the Bessemer process was extended to pig iron rich in phosphorus that Alsace-Lorraine at one sweep obtained an enormous importance, the more so because the Lorraine ore deposits extended far into the Luxemburg, which at that time belonged to the German custom union. Financed by German money, an extensive iron industry now originated in the course of 20 or 30 years in Alsace-Lorraine and Luxemburg which at first was restricted to the production of pig iron. The coke required by the blast furnaces was supplied by the Westfalian coking plant. It was not before the 90's that the Alsace-Lorraine iron industry started to embrace steel making as well by erecting steel works and rolling mills. This development reached its summit by the construction of two German mixed works fitted with

the most up-to-date equipment through two large German concerns, the Adolf-Emil mill in Esch, Luxemburg, through the Gelsenkirchner Bergwerks Gesellschaft, and the Thyssen mill at Hagendingen in Lorraine through the Rhenisch mill owner, August Thyssen. Both works were started in 1910 at about the same time and were finished in 1912. Together they comprised 16 blast furnaces with a daily production of about 5,000 tons of pig iron, 10 Bessemer converters with rolling mills annexed for transforming the entire pig iron produced into steel products. Not only these two works, but in addition every one of the other blast furnaces, steel and rolling mills in Lorraine and Luxemburg were taken away from Germany by the peace treaty of Versailles.

The consequences are obvious from the above table. They become worse through the fact that the Rhenish-Westfalian works used to procure a part of the ore they required from the Lorraine iron ore mines while now they are compelled to buy all the necessary ore from abroad. To this must be added the other well known difficulties due to workmen's riots, strikes from political motives, the radicalizing of the men, the eight-hour day and the decrease in output per head and hour. All these causes were accompanied by the difficulties arising from the fuel supply. As early as during the war the production of coke as well as its quality had gradually dropped. The bad quality of the coke mainly showed in its increasing percentage of sulphur and ashes. While before the war the Westfalian blast furnace coke on the average showed a sulphur content of 0.4 per cent and an ash content of 9 per cent, these figures had risen to 1.2 per cent and 15 per cent, respectively, in 1920, particularly through the fact that the dressing of the coal to be coked had become worse and worse. However, by improving the method of dressing and by gradually training the coke oven workers most of these difficulties have been eliminated again. There was not only the problem of the quality of the coke, but that of the quantity as well. Through the peace treaty of Versailles and the agreement of Spa, Germany is compelled to supply 200,000 tons of coke per month to the countries of the "entente," more especially to France and Belgium. This coke has to pass a rigid examination by inspectors appointed by these states, and only coke that is of high grade quality will be accepted, the remainder showing too high a sulphur and ash content being rejected. Owing to these coke deliveries, Germany was and is compelled to procure a part of the coke required for its blast furnaces from abroad, particularly from England. It is easily seen what economical antagonism is originating as a result. In spite of the fact that the Westfalian coke ovens are directly side by side with the blast furnaces, the coke they produce is sent to France and Belgium. The quantities lacking for the German blast furnaces are fetched a distance of 300 to 800 miles via the sea, the Rhine and its tributary waterways, with the result, of course, that they become very expensive. At the time of writing, i.e., the middle of September,

*Consulting engineer. Berlin, Germany.

owing to the invasion of French and Belgian troops into the Ruhr district, there is no telling how things will develop in future. At all events, a very annoying interruption has taken place in the large scale restoration scheme which had been started by the blast furnace works together with the coke oven plants.

The outcome of the war and its political and economical after effects had no less effect on the steel works, more especially on the open hearth works. However, in this case it was not so much the question of quality, but of quantity, the solution of which was causing great difficulties. Before the war the producer open hearth furnaces used to be worked on gas almost exclusively in Germany because other suitable fuel such as natural gas and crude oil were not available. The Ruhr district and the Upper Silesian districts supplied a coal rich in gas in sufficient quantities and of satisfactory quality. The drop in the coal production as well as the supply of large quantities of gas coal to the countries of the "entente" in this case again were responsible for a serious lack of suitable fuel. It was impossible to replace this coal by brown coal for one thing, because of the great distance over which the brown coal has to be transported and, secondly, because by using brown coal the temperatures required in steel making cannot be produced at all. Certainly some plants have adapted operation to the gasification of brown coal briquettes, and after furnaces and producers had been made suitable for this fuel satisfactory results were obtained. However, this solution was only feasible for plants that are situated close to brown coal mines. Furthermore, the production of

briquettes, which itself is limited by the capacity of the briquetting plants, could not be increased to any appreciable extent. There is also the fact to be considered that the brown coal briquettes in the first place have to cover the demand for house coal.

In many plants the coal requirements of the open hearth furnaces were satisfied by adopting other kinds of gases, such as blast furnace and coke oven gas. In this connection many fuel problems have sometimes been solved in an interesting manner. It is a well known fact that coke ovens are heated by means of coke oven gas in many cases. Now it was found that blast furnace gas, which is of much lower grade, will be quite sufficient for this purpose. In other coke oven plants where blast furnace gas was not available, the gas necessary for heating the coke ovens was gained by the gasification of waste coal. Large volumes of coke oven gas have been released in this manner to be utilized for the heating of steel furnaces.

When operating open hearth furnaces with coke oven gas deprived of its tar contents some difficulties were met with in so far as the coke oven gas burns with non-luminant flame, while the furnace men are used to the luminant flame of the tar containing producer gas. However, by long and painstaking training the men have gradually been accustomed to the non-luminant flame, and the problems arising from this aspect of the matter can now be considered as settled. In some large steel works it has even been possible to obtain the temperatures required in the furnaces on a mixture of coke oven gas and blast furnace gas and to produce a good quality steel with certainty in this man-

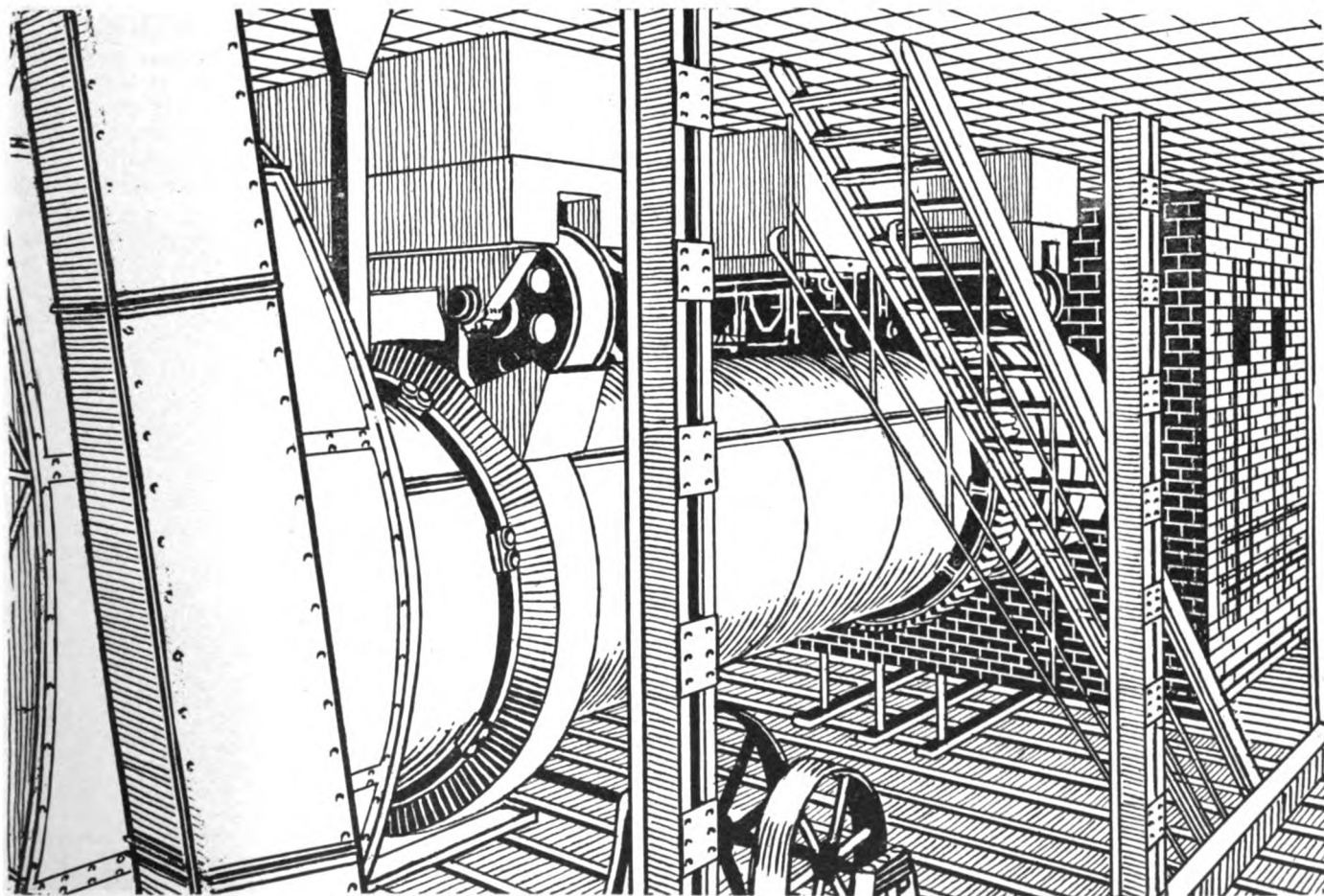


FIG. 1—Great revolving drier used in the preparation of brown coal now found available in metallurgical operations.

ner. Mixtures of coke oven gas and producer gas have also given satisfactory results. It has been found that by intelligent co-operation of science and practical engineering, solutions can be obtained that will be satisfactory in an economic direction as well.

This favorable development is principally due to the heat economy offices that have been set up in the various works. Although the heat economy office of every individual plant is independent and will be managed independently and to the best advantage of the plant it belongs to, all heat economy offices are combined in an organization called *Warmestelle des Vereins deutscher Eisenhüttenleute* (Heat Saving Office of the Association of German Iron Metallurgists), the latter being the scientific institution of the German Iron Metallurgical Engineers. This centralized heat economy office is collecting the results of the

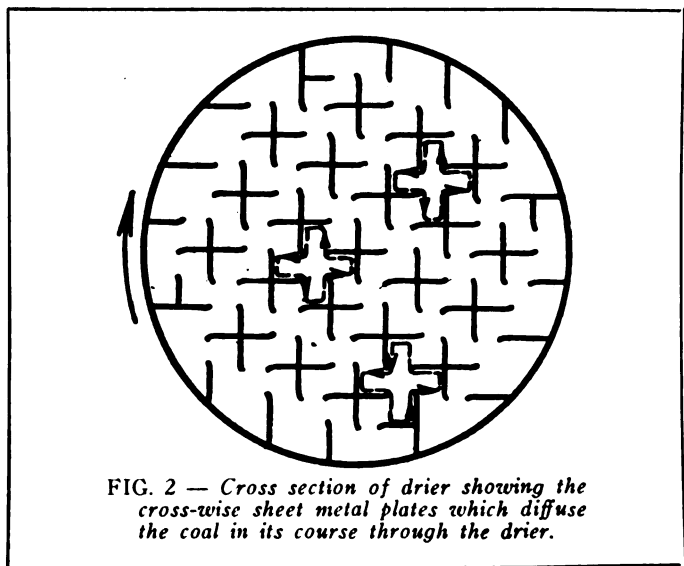


FIG. 2 — Cross section of drier showing the cross-wise sheet metal plates which diffuse the coal in its course through the drier.

different heat offices, communicating them subsequently to the several plants. It is safe to say that owing to these arrangements the total coal consumption of the German iron works has been reduced by 10 per cent per ton of raw steel. There can be no doubt that this figure will be further improved.

For heating furnaces, forging furnaces, etc., that do not require very high temperature, brown coal has been tried quite recently. However, in its crude form, with high water content, brown coal cannot be used for this purpose. By extensive experiments, on the other hand, it has been proved that dried brown coal may easily be reduced to powder and that with this powdered brown coal temperatures up to 2100 deg. F. may be readily obtained. The brown coal is dried in large drums, as shown in Fig. 1, which are heated either by waste heat or by burning coal. The whole cross section of the drum is filled with sheet metal plates arranged crosswise, as shown in Fig. 2, so that during rotation of the drum the coal will gradually dribble down finely distributed and at the end of the drum can be removed. According to the results obtained by several German rolling mills, it will be possible in future to cover an additional portion of the fuel requirements by using brown coal. So far the brown coal is still ground and dried in the individual plants. However, from an economical point of view, it would be preferable to carry out grinding at the brown coal mine and to convey the coal in dried condition to the various works. A number of engineering

problems referring to the transportation of the coal arise in this connection which have not been solved up to the present, but the solution of which is carefully studied.

WASTEFULNESS OF HIGH ASH IN COAL

(Continued from Page 103)

I said that we got the coke from The Portsmouth Solvay Coke Company, Mr. Replogle said, "Then the remedy is in your own hands." I replied, "But the ash is in the coal and we control only a part of our coal mixture."

Long before this meeting I realized that poor coke, either in analysis or structure, was responsible for many of the troubles at blast furnaces, but since that time I have been working harder than ever to bring about a condition where the high ash in coal could be so reduced that there would be very little slate or clay or sandstone or any other dirt shipped from the coal mines to the consumer of the coal. There have been many difficulties to overcome. Probably the greatest difficulty has been the ignorance of nearly everybody concerned regarding the wastefulness of high ash in coal.

Many people have taken high ash coal as a matter of course, and all they have done has been to take out the ashes from their kitchen stove or from their furnace heaters and do a little kicking, and then forget about it until next winter. It is only within comparatively few years that iron and steel men have fully realized the wastefulness and the expensiveness of shipping high ash coal to the coke ovens for making blast furnace coke. Even today there are many conditions existing which force iron and steel men to use high ash coal in their coke mixtures. Even if the steel company owns its own mines and even if it has capacity enough to supply its needs it often happens that special orders of the Interstate Commerce Commission will bring about a distribution of car supply so that the steel company will receive only half cars enough to get all its coal from its own coal mine, then it becomes necessary to purchase coal on the open market and in many cases these purchases of coal will be higher in ash than coal coming from the steel company's own mines.

Not only does slate and clay and other dirt cut down the value of the coal but it actually takes part of the good coal to smelt the ash. In the blast furnace the coke and limestone and ore are filled into the top; the coke is burned to gas and the gas reduces the iron ore to iron and the limestone fluxes out the impurities of the coke and of the iron ore. It takes fuel to generate heat enough to smelt the ore and to bring about the chemical reaction for the making of the pig iron. If there should be only as little as one pound of slate extra in every 100 pounds of coal then the coke made from that coal would be worth 30c a ton less than if that one pound of extra slate had been thrown out.

The slate that is shipped in the coal requires just as many railroad cars as if the coal were all clean, but the value of the coal when it arrives at its destination is cut down by each pound of slate or clay.

The cleaning of the coal starts at the working place and every time that a miner throws out a piece of slate he is doing just that much more to bring about the shipment and the use of clean coal.

THE SAFETY CRUSADE

Highway Safety Guard

Forty Per Cent of Highway Accidents Result from Cars
Going Over Cliffs or Bridges

THE perfection of a successfully tested highway safety guard applying the principle of the aerial life net to prevent embankment, bridge and curve accidents which cost the lives of hundreds of motorists annually was announced at the Chicago Good Roads Show the week of January 14.

The appliance, a ribbon of woven wire so fabricated as to absorb impact, is designed to replace wooden rails, stone walls and cables along highway "danger points." Placed on top of curves, cliffs and at bridge approaches and sides it stops skidding or speeding machines that hit it by the stretch of its fabric without destructive impact or the ordinarily serious damage to the car or injury to occupants.

Tests of the guard demonstrated that it is impossible for a machine speeding as high as 45 miles an hour to break through it, according to W. T. Kyle, general manager of the Page Steel & Wire Company, who sponsored it. It was produced by the Page Company, as the result of two years' of highway engineering experiments "in the interest of public safety" and is comparatively inexpensive, according to Mr. Kyle.

"Forty per cent of highway accidents and many of those in cities result from cars going over cliffs or bridge sides," said Kyle. "Highway engineers have for years been searching for a guard to replace wooden

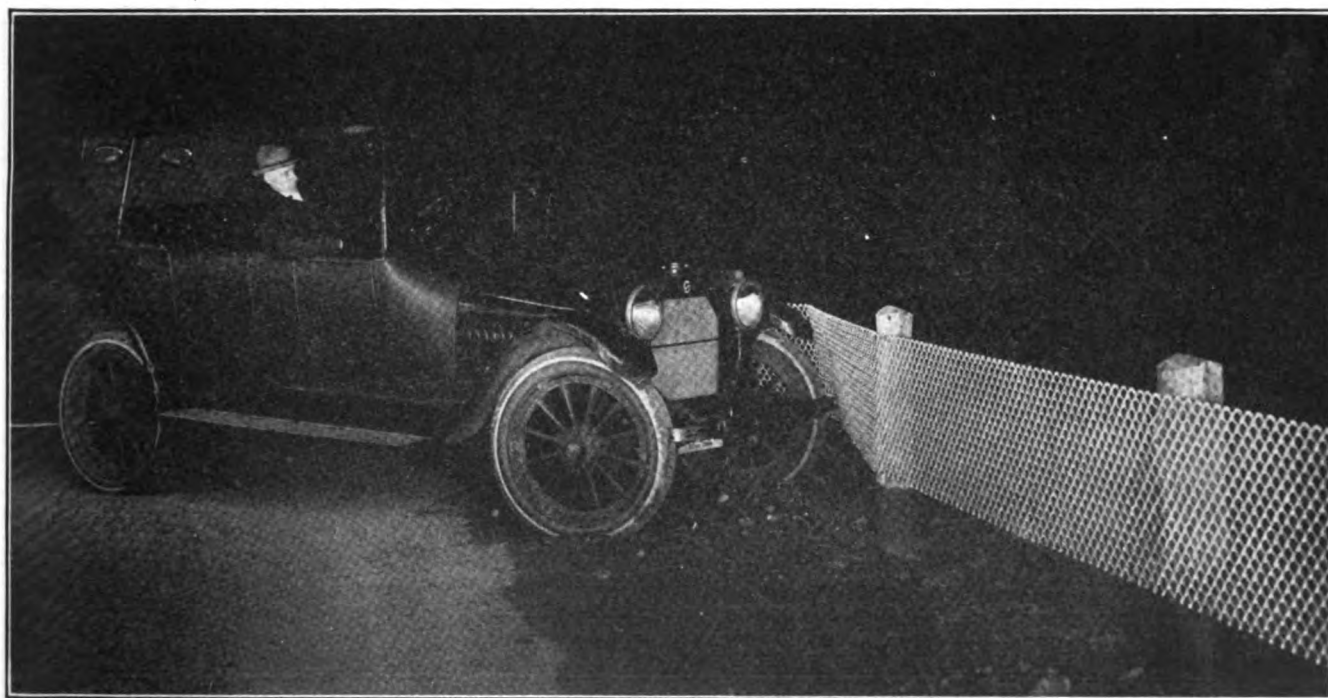
rails, which serve merely as a warning, and stone walls and cables which, if hit with any violence, break through, or wreck the machine because of the impact.

"The highway guard was built under a method of fabricating wire, that would give a maximum of strength, elasticity and recoil. It has been thoroughly tested under the Underwriters' Laboratory bumper impact test, and also was rammed, as a supplementary test, by automobiles.

"In the Underwriters' Laboratories' bumper impact test the guard was stretched between two regulation posts and fastened to each post with ordinary 1½-inch staples. A 650 pound weight, suspended at a point 68 feet above its center was drawn back 30 feet and allowed to strike, the force being equivalent to that of a 3,000 pound car traveling 20 miles an hour.

At each of four severe blows the fabric narrowed and elongated, acting in buffer fashion demonstrating it will stretch until the wires forming the meshes rest against one another. At each blow there was a recoil, diminishing as the guard was pounded, and the shocks were entirely taken up between the two posts.

"In the subsequent automobile tests machines hitting it at moderate speed were brought to a stop, the recoil pulling them back from danger. With the cars going at high speed, the meshes, giving similarly,



Photograph of an automobile striking highway guard at high speed.

'wrapped' around the hood, allowing the blow to spend itself evenly on the wheels, bumper, etc. Even though a blow might displace a post, in such a case, the fastenings farther away hold and the car is held."

Comparative tests were conducted before Connecticut State Highway officials with 4,000 pound machines going 20 miles an hour. The guard was only slightly affected. The cars were not damaged. Standard wooden railings hit at the same speed were totally wrecked and the cars, smashing completely through them, were completely wrecked.

The guard can be installed unbroken for any distance and if one section is caused to "sag" by a blow, that section can be replaced. Sections on either sides are not damaged. The guard is galvanized and painted white, making it easily visible at night. It is constructed of 24-inch wire link fabric. The mesh, formed by No. 9 wire, is square and is $1\frac{1}{2}$ by $1\frac{1}{2}$ inches.

Highway officials of three states who witnessed tests and demonstrations announced that they are writing it into their specifications, making it standard for use in their states as a "practical method of preventing incline accidents." The Ohio State Commission has ordered it installed immediately at a famous "death curve" at Columbus, and representatives of other states, as well as representatives of the U. S. Bureau of Public Roads, are arranging tests.

"The National Safety Council and other competent authorities estimate that the economic loss from traffic accidents for each 100,000 population in the United States totals \$1,500,000." Kyle declared, "We believe that this problem is one that industries must solve practically for their own good, and this fact caused us to deviate from our usual activities and set aside a special fund that was used in 'Highway Guard' research."

Electricity Saves Tots' Lives

Ever since electricity passed from the experimental stage to true usefulness, man has recognized the debt he owes to the discoverers and exploiters of this magic force. The yearly saving resulting from the use of electricity in the United States has been figured out by statisticians in dollars and cents. This, they say, is man's debt to electricity. But now, when electricity has been the direct cause of saving two tiny human lives, debt is increased beyond measure of finite values.

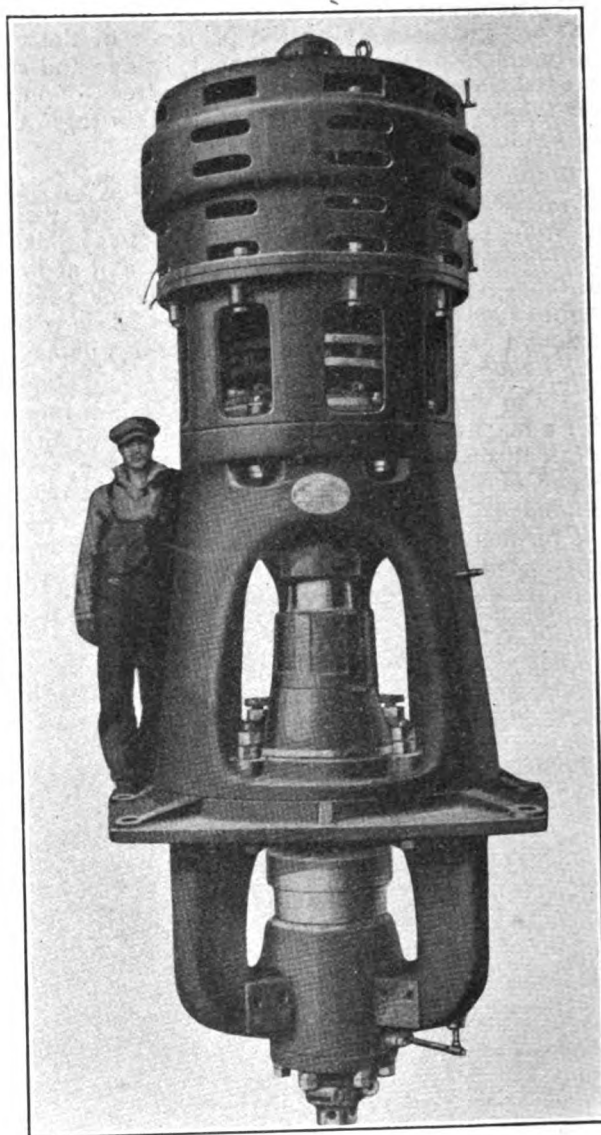
About two years ago, twins were born to Mr. and Mrs. E. N. Horr, of Cleveland, Ohio. Unfortunately, this birth occurred prematurely and the twins weighed less than two pounds apiece. Prompt action on the part of physicians and the use of modern hospital equipment kept the tiny sparks of life burning, although no one expected the babies to live for more than a few days.

Then Mr. Horr conceived a method of prolonging and possibly even saving the lives of the two little ones. He built a light wooden frame, rectangular in plan and about 18 inches high. On this was placed a rectangular basket made of square bars and covered on the sides and bottom with copper screen. The framework with the basket on top of it was placed inside a beaverboard enclosure built in one corner of a bedroom. Two 600 watt, 115 volt Westinghouse space

heaters were mounted underneath the basket near the floor, supported on ordinary porcelain knobs and electrically connected to a plug which entered a socket on the beaver-board wall. The heat was so regulated that the temperature within the enclosure was kept evenly at 85 deg. F.

In this ingenious incubator, the tiny twins made their home for many weeks, growing stronger and healthier in the warm basket. They are now nearly two years old and no longer need the protective warmth supplied by the heaters, which Mr. Horr is now using in the fruit room of his basement.

—Westinghouse Bulletin.



GIANT GYRATORY CRUSHER

Bulletin No. 27, recently issued by the Morgan Engineering Company, Alliance, Ohio, is devoted to a description of their Weston direct drive gyrating crusher. This remarkable piece of reduction equipment is the outgrowth of 12 years of diligent and searching work in crushing plant operation. Its enormous size is shown in the accompanying illustration. The gyratory crusher for secondary work has been taken out of the class of machinery that requires constant repairs and placed in the class where lubrication is perfect and friction negligible. All wearing parts are inexpensive and easily replaceable.

Developments in Metallurgy

By S. B. GOODALE*

INVESTIGATIONS have been reported upon the most varied subjects. These include both studies of fundamental matters for information to be used in many applications, and studies of many of the individual processes and appliances, raw materials and products of the industry. It seems as if, more and more rapidly, the industry is turning to science in the effort to improve operations, and more than ever before turning to technically trained and experienced men to solve its problems. Moreover the results of these studies are showing in economy, increased production with given equipment and personnel, and better quality of product. That is to say the industry is now supporting research, and research is now contributing largely to support industry.

Blast furnace practice may be on the eve of another revolution, by the introduction of the use of oxygen on a large scale, either as the pure gas or as oxygenated air. Experiments now under way are being made with this as the object. With oxygen gas available at a cost of \$3 per ton, the possibilities are very alluring. Much has already been done by the oxygen committee of the U. S. Bureau of Mines in studying the probable advantages of its use and in indicating lines along which the use of oxygen may be profitable.

The study of coke has been carried on very extensively by different organizations to determine both the effects of various factors in its production on its quality, and the effects of different qualities of the coke in furnace operation. The combustibility of the coke refers to its comparative rate of being converted into carbon monoxide under definite conditions. Opinions seem to vary widely on this matter. Bureau of Mines investigation seems to have shown that the principal factor to influence rate of combustion is the size of the individual pieces of the coke, and that coking time and temperature, porosity, volatile matter, and specific gravity differences made little difference. It seems that different samples of coke do vary in their relative combustibility in air and in CO_2 ; and it is probable that the ordinary idea of combustibility as that term is used in blast furnace and cupola practice may really have more concern with the action of CO_2 than with that of the free oxygen of air on coke.

Experiments made recently by the Bureau of Mines at St. Paul in their experimental furnace, in which some three tons of pig iron per day were made for a considerable period, showed that the oxygen of the blast was all converted into CO within a very short distance, some 32 to 40 inches of the tuyeres. In these tests a number of runs were made under conditions permitting careful observation and the recording of unusually complete data in regard to reactions in the furnace. The results of this work are being published in this magazine. Other studies made by the same organization showed that the great differences observed in blast furnace operation with different cokes are due to other factors than differences in the combustibilities of the cokes in the tuyere zone.

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Still another investigation of the Bureau of Mines dealt with the difficult sulphur problem. Coke contains four characteristic sulphur forms, but it is probable that the bad effect in the blast furnace is the same for all forms. No actual study of the iron, coke and slag at various levels in the furnace has been made with this question particularly in view. A good deal has been done recently, however, in regard to removing sulphur from iron in the ladle. The desulphurization of pig iron for foundry use has been effected to a notable extent by treatment of the clean metal surface in a ladle with soda. The slag must first be skimmed off, and a small quantity of soda is thrown on the metal. In certain tests 40 per cent of the sulphur was removed in $2\frac{1}{2}$ minutes, and if the metal is hot enough the treatment can be repeated and an additional amount of sulphur removed.

An interesting series of tests was run at Trumbull Cliffs early in the year to determine how much coke was needed to melt scrap turnings, etc., when added to the blast furnace charge, or whether any coke in addition to the regular amount for the ore used were necessary. The result of the tests showed that little if any additional coke had to be used for an addition of turnings or borings equal to 5 per cent of the product made. In these tests it was also found that the use of non-magnetic hard ores crushed to pass $2\frac{1}{2}$ in. ring assists materially in fast driving of the furnace.

At the Monessen plant of the Pittsburgh Steel Company dry dust cleaning has been attempted by filtering the gases through a bed of deposited dust. The filtering bed is in a nearly vertical position, held between alternating grids so as to maintain a nearly constant filtering curtain, which permits the passage of about 14 cu. ft. of gas per minute per square foot of curtain area. The resulting gas contains only .083 grains of dust per cu. ft. as against wet washed gas at Monessen .122 grains. An experimental Cottrell precipitator has been installed at the plant of the Colorado Fuel & Iron Company at Pueblo, Colo., for dry cleaning of blast furnace gas. These experiments with dry dust cleaning presumably acquire added importance in view of the work being done with oxygen enriched air; as the most effective gas utilization when using oxygen will become much more important than with natural air.

A very belated but important experiment has been made at Anyox, B. C., in the way of producing pig iron from the slag of a copper smelting furnace. This slag contained in the neighborhood of 52 per cent of iron; and pig iron has been produced from it on a laboratory scale. It would seem to be only a question of time and work until the iron in such slags would be practically utilized as regular practice. With this slag discharged molten from the copper furnace, an appreciable portion of the heat required for iron production is already present in the raw material; and instead of having to pay for iron ore, the producers are relieved of at least a part of the cost of handling a waste product.

A new scheme of banking a blast furnace is reported from the Cockerill Works at Liege, Belgium. This

reminds one of quenching, but the quench was accomplished by preventing the infiltration of air about the lower part of the furnace by applying a back pressure at the top of the furnace. The furnace was thus allowed to cool in statu quo; and some 18 months later was restarted by simply applying hot blast. The first tap is reported to have been made some 6 hours later. A very reasonable, and apparently successful, experiment.

The study by any and every means known of the structure and properties of finished metals, and of how these can be controlled and improved is now probably the branch of metallurgy into which more careful thought is put than into any other. The literature of metallography has been enriched by several excellent books in recent months, of which reviews appear elsewhere and, more importantly, by the reports of much original study. It has been well suggested, however, that probably the most beneficial piece of work some genius might accomplish would be to bring together into a workable hypothesis the scattered masses of data that now exist. We need to have some general theory to connect accurately what we know of structure in both the atomic and molecular sizes, and in the larger crystalline entities, with variations in those properties that are of value and use to mankind. Along this line comes the important contribution made in Dr. Rosenhain's Institute of Metals lecture on solid solutions, and his lectures while on tour in this country.

The study of various methods of testing is being carried on more and more extensively. The phases of testing that have been noticed by the writer as seeming to have particular present day prominence are the continued work on impact testing, and on fatigue testing, also on the testing of the properties of metals as they are affected by considerable changes in temperature. The present day tendency in boiler practice toward higher steam pressures and higher superheat makes the question of the properties of boiler steel at these higher temperatures one of very great interest. Rapid progress has also been made in the application of the X-ray to examination of metal, and the method seems to be approaching the state of development such that possibly it can be very generally used in the near future. Shadow pictures can be made through steel up to at least 3 in. in thickness, the penetration of the rays through the thicker metal seeming to be intimately connected with the voltage used in the X-ray apparatus.

The metallurgical department of the U. S. Bureau of Standards is doing much valuable work on fundamental investigations of the type not usually of sufficiently immediate application to the work of any one industrial concern to force this work to be done by that concern. Among the investigations in progress are studies of the crystalline structure of ferrite, and of the effects of phosphorus and of sulphur in special kinds of steel.

Notable advances have been made in magnetic testing by deForest of the American Chain Company who has developed a rapid method for determining the different effects of two different factors in the treatment of steel by measuring more than one of the principal magnetic qualities of the material. It is now recognized that materials may have several kinds of magnetic qualities which may be separately determined. Mr. deForest's work stands out as being

of pioneering character, as having already achieved important results and as opening up new fields for further progress.

Interesting results have been reported from Lehigh University of a development in a scientific and useful way of something that is doubtless first cousin to the old "tin cry". When a sensitive microphone is applied to metals being stressed under test, a sound is made audible which is emitted by the metal immediately after the elastic limit has been exceeded, no sound having been observed before. (Perhaps, in time, we may be able to tell from the note that any particular piece emits, under suitable control, and by measuring all modulations of the sound, overtones, etc., all about the crystal form of its crystal unit and in a somewhat grosser size unit accomplish something analogous to what the X-ray is doing in the atomic field.) Seriously, however, the new method may be applied to determine if any structures in use are being dangerously stressed, and it would seem that in many cases this information could be had at a time that would prevent imminent failure, or would permit of preparations being made to lessen materially the serious results of failure.

A new hardness testing machine has been brought out by Mr. Edward G. Herbert, of Sheffield, England, called the pendulum hardness tester. A one millimeter ruby or steel ball supports at or near its center of gravity a yoke free to swing, the ball rolling back and forth on the surface to be tested. Work is done by the ball, minutely or more, deforming the surface, more work being done as the surface is softer; the effect of this work on the amplitude of swing is noted, and the work done estimated thereby, this being connected with hardness.

Considerable progress has been achieved in illumination for microscopic examination of opaque pieces. Some very nice results were reported in the Transactions of the American Society for Steel Treating, for August which were secured by a form of oblique illumination called conical. In addition to the means suggested in the original paper by Mr. Harry S. George, of the Union Carbide and Research Laboratories, Inc., Long Island City, it is here suggested that the form of incandescent light now so generally used and called "Mill type" should give the desired results and perhaps by means easier to arrange, although not giving such an intense light. The radiating filament of this lamp is arranged to occupy roughly two thirds of the circumference of a circle, supported at intervals. This would seem to be capable of giving a very good relief effect, as the light from one side would be stronger than that from the other side. Incandescent lights are increasing in favor for illuminating anyway, because of their greater convenience over the arc, where the arc has to have such frequent attention for adjusting the carbons as they burn away, especially when made so small as in some modern transparent metallog apparatus. The small carbons work very nicely when properly centered but they do burn away very quickly. To overcome this difficulty a new lamp has been devised consisting of a ribbon of tungsten mounted in a nitrogen filled bulb. When this is once mounted in connection with the microscope it remains in alignment permanently, and is sufficiently brilliant for photographic work. Still another lamp is the "Point 'o light", a very brilliant special type of arc with tungsten ball for the hot spot.

In the field of alloy steels, much work has been done on zirconium as an alloy addition. This element combines energetically with oxygen, nitrogen and sulphur, in the order named and is able at least, in part, to neutralize the embrittling effect of phosphorus in steel. A small addition of zirconium is said to make possible the rolling of steel containing unusually high sulphur.

The zirconium treated steels seem to be relatively clean, perhaps because the zirconium oxide unites with the alumina and silica becoming readily fusible and rising quickly to the slag. Zirconium treated experimental lots of steel showed an average of 54 per cent reduction in oxygen over the silicon treated metal, and a lessening of nitrogen from .0072 per cent to .0035 per cent. Minute yellow cubic crystals of ZrN are present in steels which have received more than .1 per cent of Zr. Zr is said to have a stronger affinity than even manganese for sulphur. Steel with .2 per cent S with .22 per cent Zr has been rolled into sheets free from seams and cracks, also steels of .29 per cent S which carried .43 per cent Zr where untreated steels with these amounts of sulphur usually broke in the first pass through the rolls.

A great deal of work is being done on the stainless types of steel. Many compositions and heat treatments are being tried out in the effort to secure something which will be really stainless. The effects of temperature changes on these steels have been studied in England and English metallurgical works are specially active in the search for better rust resisting material.

A brief report has been made of a series of experiments on the addition of tellurium to steel. This element forms a compound, FeTe, with iron which behaves very similarly to manganese sulphide in the metal. In forging it elongates as well as or better than manganese sulphide. The steel containing this element appears to be somewhat lower in ductility than the normal steel.

The influence of nitrogen in steel was further reported on during the year together with careful work in regard to the determination of nitrogen in the metal. The difficulty of determining nitrogen in steel is partly due to the necessity of determining the element in the presence of the same element in most of the surrounding materials. The investigation mentioned which was carried at the Massachusetts Institute of Technology under the direction of Professor Henry Fay has resulted in increasing the reliance placed on the distillation method of determining nitrogen.

A very extensive paper was presented early in the year as the last contribution from the late Doctor Henry M. Howe. The work which was initiated by Dr. Howe was finished in an able manner by several of his colleagues. It reported an extensive series of experiments to determine the influence of temperature, time and rate of cooling on the physical properties of three carbon steels.

For foundry use a new arrangement of melting units has been brought out by a Pittsburgh firm, called the "multiple electric melting system". Two furnaces are erected on a turntable, with a single complete electrode holder unit at one point. At any moment melting and refining will be carried on in one furnace spotted under the electrodes; while the second furnace is spotted at the pouring position and has

time to discharge its contents and have its lining repaired while a heat is being made. By means of this arrangement a very high load factor can be maintained on the electrical supply system.

Another novel melting arrangement, the Schuermann system, is a side blast cupola which has been introduced in a Chicago plant. The blast is introduced through tuyeres on one side, while the waste gases are taken off through other tuyeres opposite and at or near the same level, and are used for preheating the blast. A saving of some 25 per cent of coke is claimed for this scheme, and a similar reduction in sulphur. Oxygen is admitted to burn the CO in the waste gas for more effective utilization of this heat in preheating blast. It is claimed also that the life of the cupola lining is increased with this method.

Centrifugal casting, although the basic ideas are very old, is only now coming into use on such a scale as to be of large commercial importance. Several groups are interested in developing specialties in this general field, and the writer believes that the method, with various modifications will be of very great commercial significance within the next comparatively few years. The method really can be applied practically to a great variety of products of a diameter greater than, say, 3 in. Piston rings, for instance, for internal combustion engines can be cast using cores that completely surround the casting in a lined mold. The molds used in the DeLavaud process for making cast iron pipe may stand up to some 3,000 heats. The annealing of the pipe cast in the chill molds is an essential factor in this process, and can be started while the pipe is still hot from casting. Casting in heated molds has been developed by Mr. Cammen for such metals as steel, monel metal, and brass. It is necessary to use special alloys for such molds, as ordinary materials will not stand the service at the temperatures necessary. The surface of these molds must be very smooth, the molds must be rotated at closely controlled speed, and the temperature of the metal at pouring must be correct. With all these conditions right, excellent castings will result.

In steel foundry practice a somewhat radical departure is described in the annealing of low or medium carbon steel castings by Mr. L. R. Mann, of Sivyer Steel Castings Company. This consists in a long high temperature anneal to diffuse the carbon more thoroughly throughout the Austenite; followed by a relatively rapid cooling through the transformation range. Castings annealed 7 hours at 950 deg. C. and oil quenched had a minute grain size, ferrite well dispersed and not in continuous envelopes. The structure is stated to have resembled closely that of good forgings; and the metal showed an elastic limit of some 63,000 pounds per square inch.

In several connections of late the subject has been more and more emphasized by Prof. Sauveur, of Harvard University, Dr. Saklatwalla, and others of the desirability of controlling the primary crystallization of metal in solidifying. It is pointed out that a very great deal of effort has been expended in attempts to control the secondary crystallization during the transformation range, but that relatively little has been done in regulating the primary crystallization. This is probably due to the difficulty of the thing. What agent or agents can be made to penetrate a mass of molten steel and regulate the grouping of the crystal elements as they form from the liquid and grow? It

might be accomplished, perhaps, by mechanical agitation of the right extent; and this may, in fact, be what happens in centrifugal casting. The control of this crystallization by means of electro-magnetic effects has been considered, and would seem to offer considerable promise of availability.

In open hearth working there have been some very interesting developments. The Basic Products Company of this city have patents on a machine for introducing refractory material for repair by means of compressed air through a 2½-in. hose line. The repairing can be started while the steel is still running into the ladle, thus saving much in heat radiated from the furnace between heats, and can be completed in less time than by hand.

The influence of temperature in the steel making process was described in a French paper by Ch. Clausel. The solubility of iron oxide in iron is nearly 0 at 1400, 1 per cent at 1700 and 3 per cent at 1800. It is therefore easier to cause oxidation at the higher temperatures. Clausel considers rapid basic steel making practice as best divided into three periods for study, the first a high temperature period of slag formation and oxidation; the second a deoxidation by phosphorus, during which this element is driven into the slag, and a final deoxidation by additions or by the reducing slag from an electric furnace. When one compares a steel making process with a chemical operation in other fields, as, for instance, analytical work in the laboratory, there is good reason to believe that control of temperature in that high temperature range above the melting point of steel may be as important to the best steel making as the control of temperature of solutions for correct results in other chemical work. The solubility of iron oxide in the metal is only one of a number of factors that will change with changing high temperature. The viscosity may decrease with rising temperature so rapidly that a high temperature settling treatment when connected with suitable chemical treatment might reduce sonims below the minimum resulting from even the best present day practice.

Steel ingot molds have been in use in some German works. The average life of some 74 steel molds was 235 heats, as against 150 heats for the cast iron molds formerly used.

It seems as if mechanical puddling may be revived again, this time with a formidable backing of capital and skill. The new plant of the American Puddle Iron Company is nearly completed as to one unit at Warren, Ohio.

In conclusion it might again be stated that the amount of investigational work being carried on by various agencies is very great indeed. It is much more than any one man can follow adequately. Such a review as the present then consists of only a few items which have happened to come to the notice of the writer and to have impressed him in going over so much of the literature as he has been able to do. There are many other developments of importance in the various fields of metallurgy.

A. S. M. E. Spring Meeting Date Changed

On account of conflicting convention dates in Cleveland in May, the date of the spring meeting of the American Society of Mechanical Engineers has been postponed for a week. The spring meeting will be held in Cleveland, Ohio, May 26-29,

inclusive. Frank A. Scott, president of the Cleveland Engineering Society, is chairman of the committee on local arrangements.

New Gold Medal Endowed

George I. Rockwood, president and treasurer of the Rockwood Sprinkler Company at Worcester, Mass., has endowed a gold medal of the A. S. M. E. to be awarded "in those rare cases when an individual has succeeded by the exercise of his genius and character, in powerfully assisting the fortunes of our country or the general engineering progress of the world." Mr. Rockwood was the guest of honor at a dinner meeting of the Worcester Section of the Society on January 14.

To Help Place Italian Engineers

The A. S. M. E. is taking an active and effective part in placing young graduate Italian engineers in industries in this country where they may gain practical experience. This work is being done at the request of the Italian ambassador, Don Gelasio Caetani, and in co-operation with the National Association of Italian Engineers, which is making a careful selection of applicants in Rome. The plan to give Italian engineers an opportunity for personal experience in American plants and industries cannot help but result in a closer friendship between the two countries.

Calvin W. Rice Plans Trip to Middle West

Calvin W. Rice, secretary of the A. S. M. E., leaves shortly after the first of February for a trip to the Middle West, where he will address meetings of engineers and student engineers. He will speak February 22 at Madison, Wis., at a joint banquet of the Technical Club of Madison and the Engineering Society of Wisconsin.

Among the cities where Mr. Rice will deliver addresses en route are Pittsburgh, Dayton and Indianapolis. He will speak to the students at Carnegie Institute of Technology, Pennsylvania State College, University of Pittsburgh, Purdue University, University of West Virginia and Ohio Northern University.

To Publish Autobiography of Dr. Brashear

Some time during the year the autobiography of Dr. John A. Brashear, a past president of the American Society of Mechanical Engineers, and often spoken of as "the humanest of all scientists," will be published. The book will appear as the next in the series of biographies of scientific men which is being published under the auspices of the Society.

A Life of Professor John E. Sweet is also nearly ready for publication.

Judge Gary to Preside at Engineers' Dinner

Judge Elbert H. Gary will preside at a joint dinner of the New York Sections of the American Society of Mechanical Engineers, the Army Ordnance Association, the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Institute of Electrical Engineers, and the Society of Automotive Engineers which will be held at the Hotel Commodore on Friday evening, February 5.

The addresses will be on Industrial Preparedness as Insurance Against War. In addition to Judge Gary, Assistant Secretary of War Dwight F. Davis and Col. James A. Walsh will speak.

Rolling Alloy Steel

At the Plant of the Harrisburg Pipe & Pipe Bending Company

By JENS CLAUSEN*

IN the following article it is not the intention of the writer to go into a technical discussion of the subject of rolling alloy steel, nor to assume that the method followed by the Harrisburg Pipe & Pipe Bending Company is the right one, and all other methods are wrong; but to describe how alloy steel is handled in that plant, and explain in a general way their equipment and their reasons for departing from the generally accepted practice.

Some time ago an advertisement of a rolling mill appeared in a technical journal, giving for its virtue

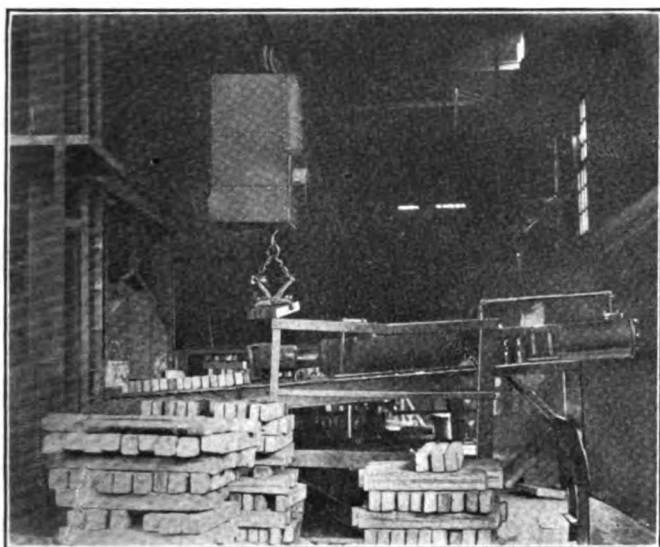


FIG. 1—Charging end of furnace showing the pusher and overhead crane.

"Maximum Production Per Man." This same thought is followed out at the Harrisburg plant, but changed slightly, viz., "Maximum Quality Production per Man." With this thought in mind they set up their equipment with the idea of furnishing the best product possible for the prevailing market price of alloy steel, and at the same time giving them a fair return on their investment.

From the open hearth through their soaking pits, blooming mill, and chipping shed, the general speed-up thought has been eliminated, especially in the mill proper where quick reductions have been displaced by as slight a reduction and as many turns of an ingot as it is possible to obtain while keeping within the proper working temperature of the steel.

Guide Mill.

The harmful effect produced on alloy steel by the sudden change in temperature from a cold billet to the highly heated furnace is well known. With this limitation in view, the Engineers of the Harrisburg Pipe & Pipe Bending Company, assisted by expert advice from the Metallurgical Furnace Department of

the Sanford Riley Stoker Company, designed a continuous coal-fired furnace. (See tracing Fig. 3.) The furnace is equipped with two Jones "Industrial Furnace" Under-Feed Stokers, each stoker having a coal-burning capacity of from 200 to 800 pounds of coal per hour. Due to the fact that a number of grades of coal were to be burned, an arbitrary figure of 160 cubic feet of air per one pound of coal was used in the calculations.

The temperature at the bridge wall was figured at 2300 deg. F., at the rear end of the furnace 1400 deg. F., in the flues 1200 deg. F., and in the stack 1000 deg. F. This equals a gas velocity at the bridge wall of 10 feet per second, half way through the furnace; nine feet per second at the charging end, 11½ ft. per second in the stack. The average time the gas remains in the furnace is 4.36 seconds.

The size of the furnaces was designed to heat 50 tons of billets, ranging from 60 to 290 pounds each, per 12 hours, using 225 pounds of coal per ton of billets. By assuming an average weight of 175 pounds per billet, the heater is allowed to take an average of 4.7 hours to bring the steel up to the proper temperature.

By charging the steel in the cold end of the furnace where the temperature rarely exceeds 1400 deg., and passing through a distance of approximately 30 feet of ever-increasing temperature, and only reaching the final heat in the last six feet of travel, it can readily be seen that this type of furnace is admirably adapted for re-heating high-grade steels.

In the design of the furnace it will be noticed that the roof is especially designed to fit the particular stoker of the manufacture above referred to, and is drawn down to have a distance of three feet from the stoker to the arch. This retards the combustion directly over the stoker so that the combustion will be completed where needed, that is, directly over the

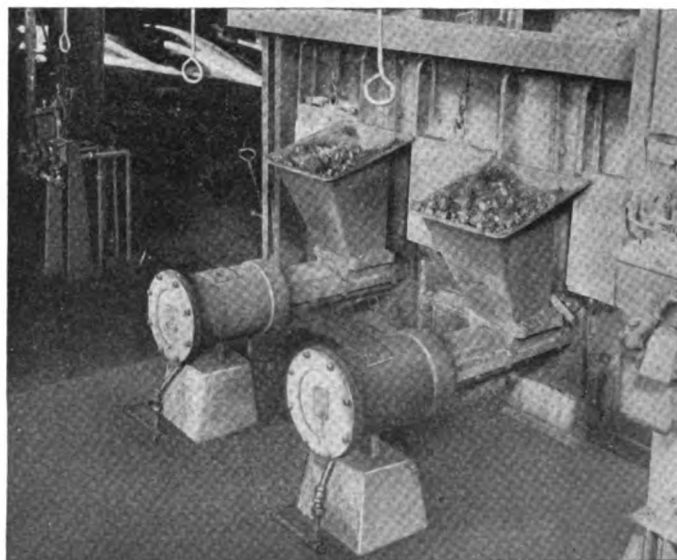


FIG. 2—View of the Jones "Industrial Furnace" stokers.

*Chief Engineer. Member A. S. M. E.

hearth of the furnace. The roof then runs straight for a distance of six feet from the bridge wall, which gives a good combustion area when the steel reaches its final temperature. The roof and bottom from this point, to the end of the furnaces, are drawn together so that the flame will have the proper velocity at the charging end.

The billets charged in the furnace are placed on the charging platform by a Shepard Hoist, and arranged in single, double or triple rows, depending

upon their weight and size, and are then pushed through the furnace by a hydraulic pusher. When they have reached the drawing door at the bridge wall each billet is tumbled and inspected by the heater before drawing. While this type of furnace can readily be equipped with a mechanical drawing device, it is felt that the heater performing this operation by giving each billet the proper inspection for uniformity in heat assures a more perfect rolling condition.

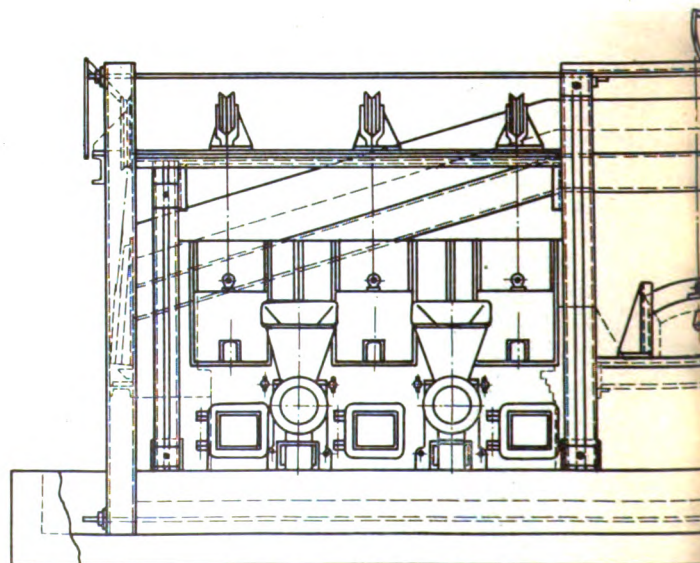
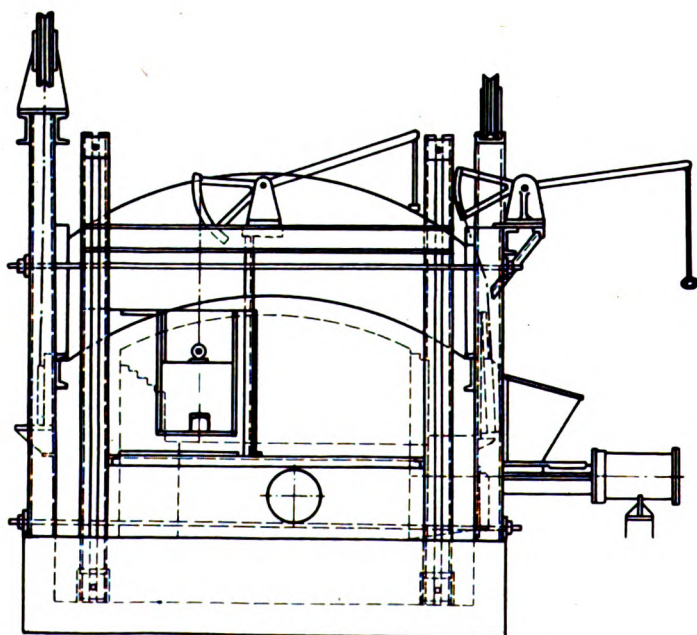
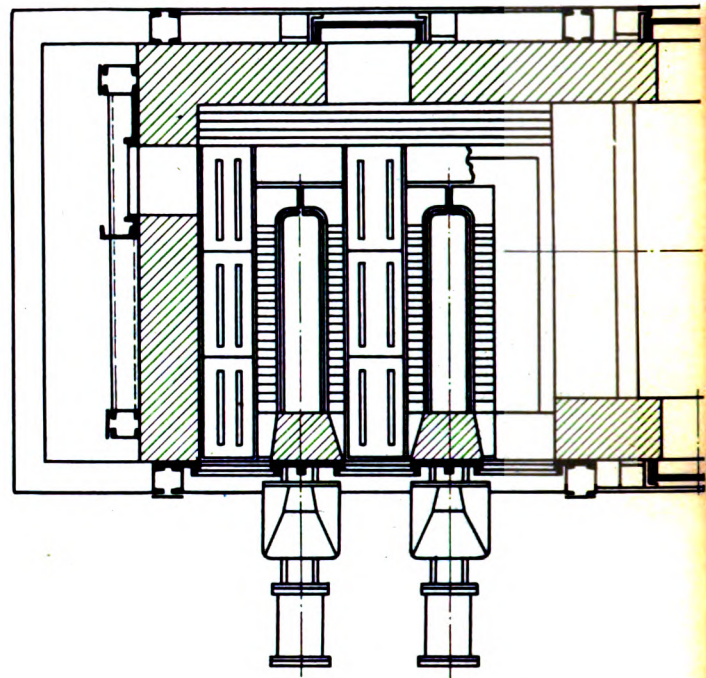
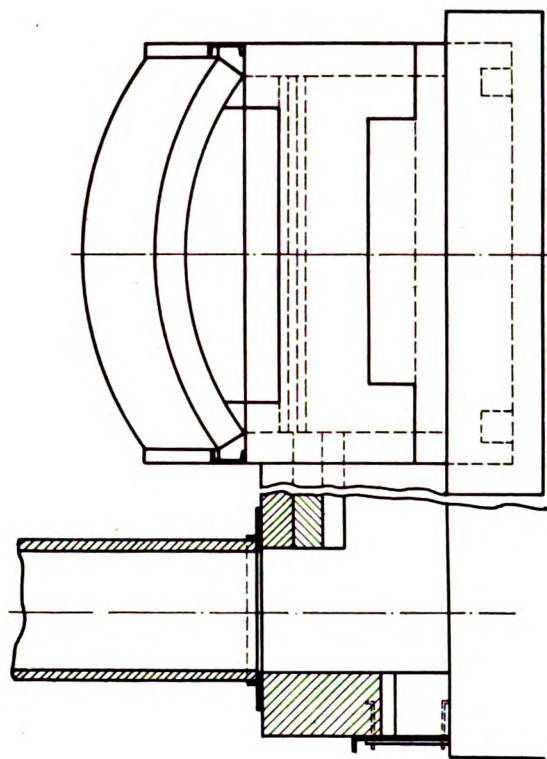


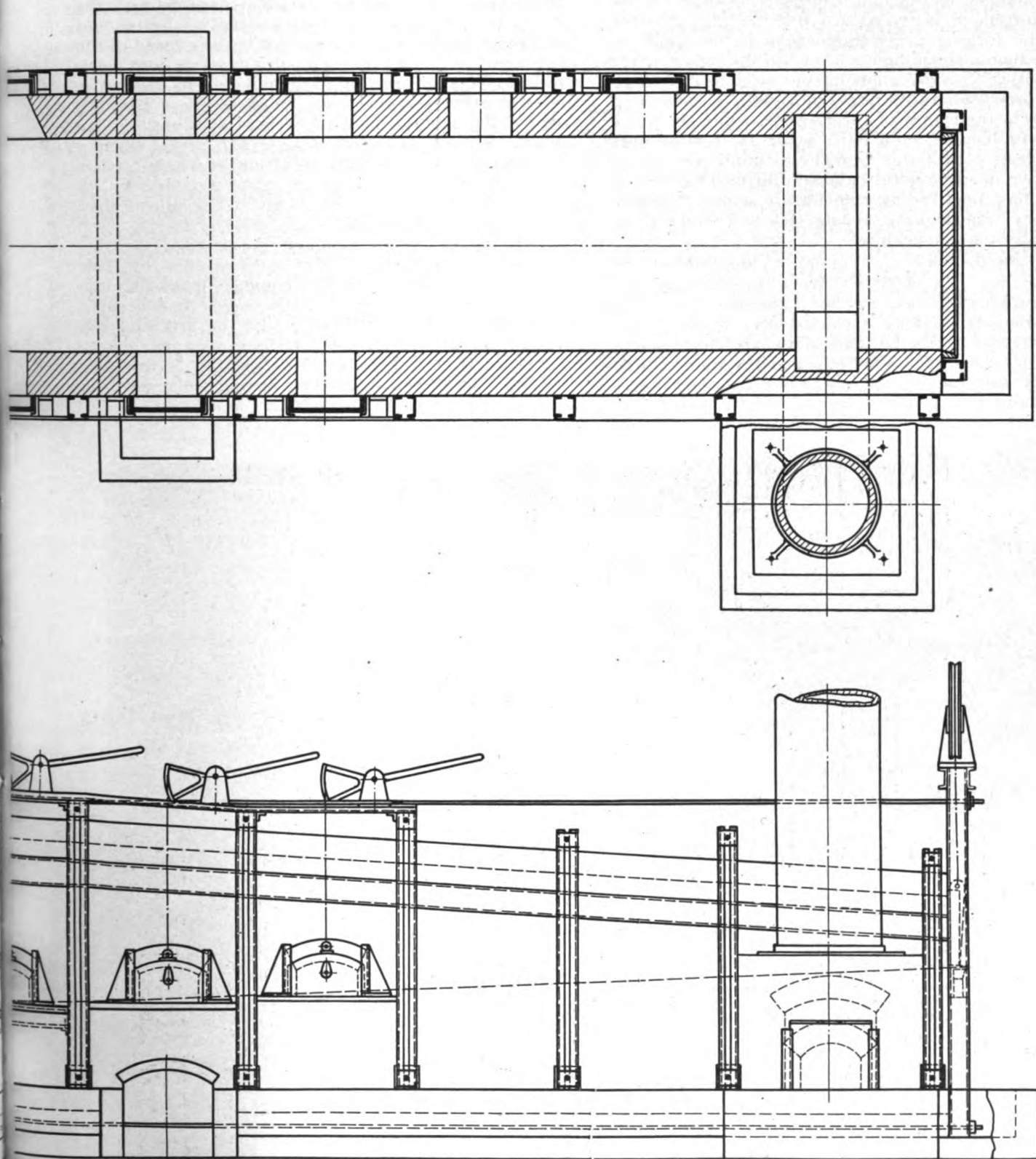
FIG. 3.—Assembly drawings of the continuous coal fired heating furnace designed especially for heating of alloy billets. A Four and seven-tenths hours is the average

It may be of interest to know that this furnace has been in operation for two years, and the cost of repairs to the stokers has not exceeded \$30.00, nor has the furnace proper from the bridge wall to the stack been repaired during this time. The brick work over the stoker has been rebuilt once, and a slight repair made at another time. The bottom has had one complete repair, and this was due principally to changing

the design from a water-cooled to a solid bottom.

This low maintenance cost is due to the fact that the stoker is properly designed and proportioned for the work and the furnace is designed for slow gas velocity and uniformity of temperature, which can be maintained in this type of furnace.

The coal consumption has been as low as 172 lbs. of coal per ton of steel; however, this consumption



variety of coals are fired on under-feed stokers. Fifty tons of billets ranging from 60-200 lbs. each are heated per 12 hours. length of time billets are in the furnace.

fluctuates with the speed of rolling and class of material rolled. An interesting feature of this furnace is that by the under-feed method of burning coal the Smoke Ordinance of the city of Harrisburg has been complied with fully.

The mill is a 10-in., three-high, consisting of five stands; steam driven, with a variable speed up to only 170 r.p.m., the mill being built by the Birdsboro Steel Foundry & Machine Company, Birdsboro, Pa.

In forging it is recognized that the slow moving hydraulic forging press produces a better grade of forging than a steam hammer, due to the slow moving of the press, thereby allowing the steel to have time to conform itself to its new shape, and thus working through to the center of the forging; while the quick action of a hammer blow has a tendency to move only the surface. With this thought in mind the mill is kept down in speed with the idea of furnishing the bar within the proper rolling temperature, and at the same time delivering it to the cooling rack at a temperature sufficient for self-annealing.

Leaving the mill, and coming to the question of piling of alloys, a departure from the generally accepted practice has been made for the reason that the usual practice of piling spring steels, or alloy steel flats, edgewise on the hot bed, allowing it to cool in a mass, then shearing cold, has many faults, among which are the rapidity with which it cools owing to the upward rush of air through the hot bed, the looseness of the pile, and the additional handling necessary

to build the stack, all of which cause excessive hardness.

The more modern hot bed of the walking type produces the same defects, only to a marked degree, as the cooling is usually in single, or only a few bars, which allows the product to cool more rapidly, and at the same time cool in spots where the strips come in contact with the fingers of the hot bed. To overcome this a runout table with a variable speed conveys the strips to a shear, where the material is sheared hot and passed on to a mechanical loader, the speed of the conveyor being adjusted to suit the section being rolled so that all sections are delivered to the loader at approximately the same temperature. The hot strip falls into the loader automatically until it has built itself up to approximately 100 strips, when a clamp is slipped over both ends and the whole mass is lifted out intact by an electric crane provided with a spreader to keep the pile straight. The pile is then set on the hot bed to cool.

The advantage of handling the material by this method is that the strips flatten themselves by their own weight, forming such a compact mass that the cooling is very slow, and at the same time keeping the strips straight. It is true that the first and last strips on the pile will not get the same annealing as the inner parts of the mass; however, this is overcome by removing these two extreme bars and placing them in the center of the following pile.

(Concluded on Page 133)

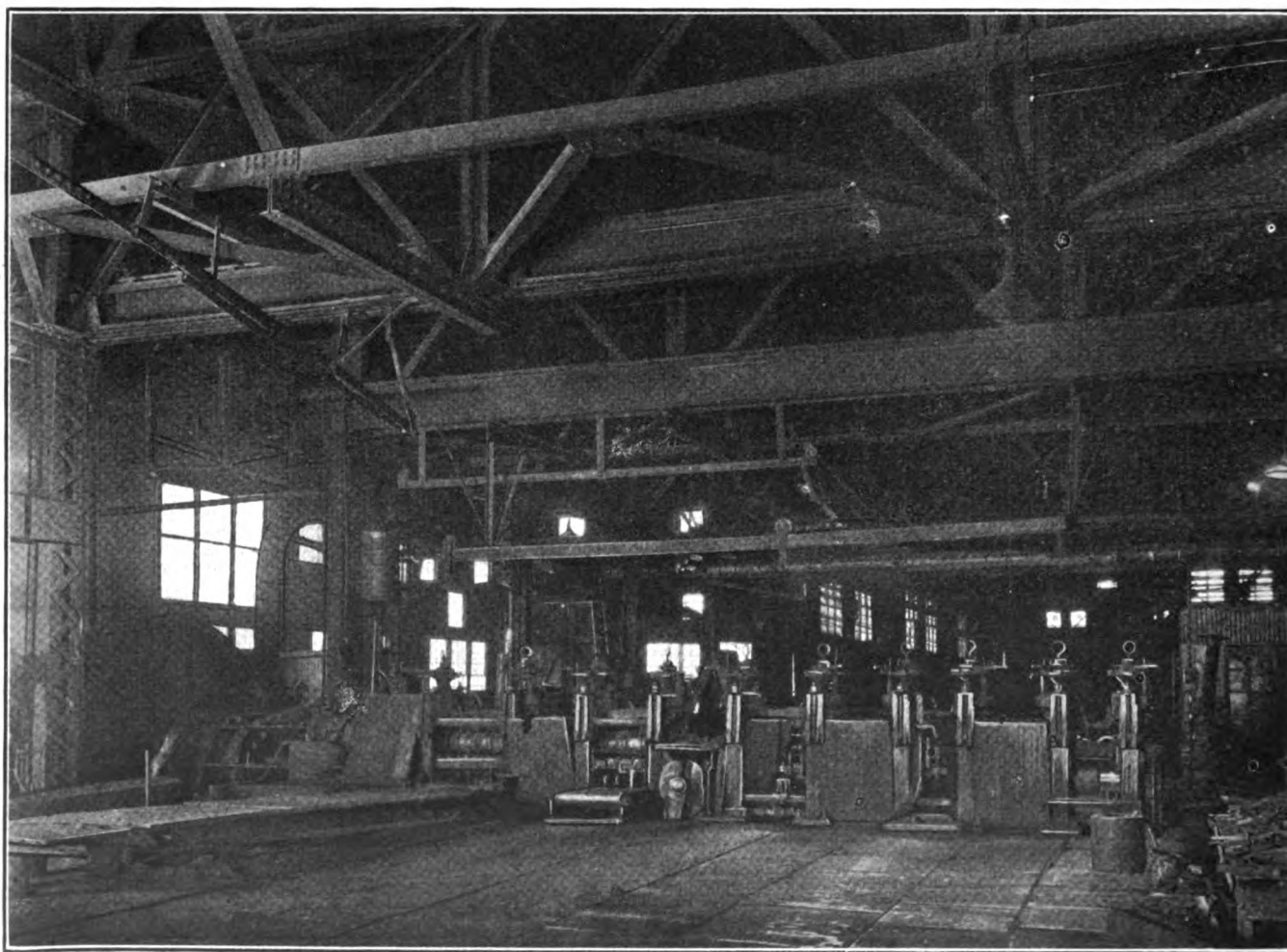


FIG. 4—Shows an excellent view of the guide mill proper.

Gas Producer Practice*

By WALDEMAR DYRSSEN†

PART II

Table IX shows such a comparison, with a seven months' and one month average record in operating a mechanical producer on coke, taken from a paper‡ by W. Reed Morris. The analyses correspond very closely. The H in the coke gas is slightly higher than the theoretical and contains some CH₄. The coke used in this run contained about 3 per cent volatile matter and approximately 88 per cent F. C. The CH₄ and a small part of the H are derived from the volatile matter. If this is taken into consideration, the Btu.

TABLE IX — COMPARISON BETWEEN THEORETICAL GAS FROM PURE C, AS ARRIVED AT IN TABLE VII, AND GAS OBTAINED IN PRACTICE FROM COKE CONTAINING ABOUT 3% VOLATILE MATTER. THE PRODUCERS WORKED UNDER WHAT COULD BE CALLED TEST CONDITIONS.

	Theoretical gas 62° F. at 2000° temperature of gasification	Seven months average analysis of gas made from coke	One month's average analysis of gas made from coke
CO ₂	3.50	3.60	3.40
O ₂	...	.20	.20
CO	31.55	29.80	30.70
H ₂	9.43	10.10	9.70
CH ₄	...	.30	.10
N	55.50	56.00	55.90
Total (per cent) ..	100.00	100.00	100.00
Btu. per cu. ft.	128.10	127.10	127.10
Lbs. of C per 100 cu. ft.	1.110	1.066	1.082
Btu. per Lb. of C in gas	11546	11923	11744

per pound of C in the gas will be practically identical with the theoretical gas as derived from balance diagrams Figs. 1 and 2. This figure constitutes the best means of comparing various gases. In the same paper are given two more analyses, which evidently indicate a somewhat lower gasification temperature, of approximately 190 deg. F. The comparison is shown in Table X. This indicates that the diagrams in Figs. 1 and 2 and the theoretical considerations are approximately correct.

Gas from Bituminous Coal.

In the calculation of the theoretical gas that can be obtained from bituminous coal, the distillation gas must be added to the gas derived from pure C gasified by blast, as calculated above. The distillation gas is, however, not subject to measurements or analysis. It can be reasonably assumed that it parallels the distillation gas from coke ovens and consists of CH₄, C₂H₄, H₂, CO, CO₂, H₂O, N, soot and tarry vapors. That the last item forms a very considerable part of the producer gas is an everyday experience in the production of cleaned cooled producer gas. The method commonly used to calculate the quantity of gas from the ordinary analysis and total C in coal is fun-

*Read before the American Iron and Steel Institute, at New York, May 25, 1923.

†United States Steel Corporation, New York, N. Y.

‡The Carbonization of Coal with Blue Gas and Producer Gas, read at the 1922 Convention of the American Gas Association.

TABLE X — COMPARISON BETWEEN THEORETICAL GAS FROM PURE C AS SHOWN IN FIG. 7, AND GAS OBTAINED IN PRACTICE FROM COKE CONTAINING ABOUT 3.5 PER CENT VOLATILE MATTER.

	Theoretical gas from blast at 62° F., temperature of gasification 1900° F., from Fig. 7	Gas from coke containing 3.54% volatile, 85.78 fixed carbon	
		1	2
CO ₂	5.1	5.1	5.2
O ₂	...	.1	.1
CO	29.1	28.7	28.3
H ₂	11.2	13.0	12.3
CH ₄	...	.3	.6
N	54.6	52.8	53.5
Total (per cent) ..	100.0	100.0	100.0

damentally incorrect. It is not possible to explain the presence as fixed gases in producer gas of all the C in the volatile matters in the coal. Bone and Wheeler found in their tests on Mond gas producers that the C in the tar was 6.1 per cent of the total C charged into the producer on coal with a ratio F.V : V.M. = 1.7. In producing cool, clean gas in this country, from 10 to 25 gallons (average 15 gallons) of tar are obtained per ton of coal. According to the exhaustive tests made by the United States Geological Survey at St. Louis in 1904 with producing gas for gas engines, the C in the cleaned gas constituted about 75 to 80 per cent of the total C in the coals, with a ratio of fixed carbon to volatile of 1.25 to 1.75. Part of the remainder was lost in the ashes, but a very large part was washed away as soot and tar. The higher volatile coals showed a lesser recovery.

We can, therefore, assume that the larger the amount of volatile in the coal, the more soot and especially tar are produced. All of the tar as well as much of the soot is undoubtedly suspended in the gas, at least in open-hearth practice, and is burned in the furnace. These constituents, as well as the H₂O, do not appear in the ordinary analysis of producer gas.

TABLE XI — ESTIMATED AVERAGE BALANCE OF C IN THE GASIFICATION OF MEDIUM AND HIGH VOLATILE COALS IN PRODUCERS. PERCENTAGES BASED ON ASH AND SULPHUR-FREE COAL ANALYSIS.

	Western Pittsburgh Coals (Per cent)	Eastern Indiana and Illinois Coals (Per cent)
Fixed carbon	About 63	About 57
Volatile matter	About 37	About 43
Total	100	100
C in volatile	21.0	22.5
Total C	84.0	79.5
C in fixed distillation gases ..	11.8	11.0
C in tar and soot	7.2	8.5
C in ash	1.0	1.0
C gasified by blast	64.0	59.0
Total C in fixed gases from producer	75.8	70.0
Percentage of total C	90.2	88.1
C in distillation gases of C gasified by blast	18.4	18.65

TABLE XII — AVERAGE COMPOSITION AND QUANTITY OF DISTILLATION GAS FROM BITUMINOUS COAL IN GAS PRODUCER PRACTICE.

Composition of distillation gas by volume (per cent) :	
CO ₂	3.0
CO	7.0
C ₂ H ₄	6.0
CH ₄	36.0
H	48.0
Total	100.0
Btu. per cubic foot.....	573.2
C per 100 cubic feet.....	1.838 lbs.
Btu. per pound of C in gas.....	31186.0
Cubic feet per pound of C in gas.....	54.4
	1.838×54.4
Cu. ft. per lb. of C gasified by blast	100
See Table XI.	

TABLE XIII

TOTAL THEORETICAL GAS FROM ORDINARY BITUMINOUS COALS GASIFIED BY AIR AND H₂O AT 2,000 DEG. F. TEMPERATURE OF GASIFICATION. ALSO COMPOSITION OF DRY GAS (H₂O EXCLUDED) BY VOLUME

	Gas from 1 pound of C gasified by blast, see Table 7		Distillation gas per pound of C gasified by blast, see Table 12		Total gas per pound of C gasified by blast	
	Analysis by volume (Per cent)	Cubic feet of gas	Analysis by volume (Per cent)	Cubic feet of gas	Analysis by volume (Per cent)	Cubic feet of gas
CO ₂	3.52	3.17	3.00	.30	3.47	3.47
CO	31.55	28.43	7.00	.70	29.10	29.13
H	9.43	8.50	48.00	4.80	13.29	13.30
N	55.50	50.00	....	....	49.95	50.00
C ₂ H ₄ .....	....	....	6.00	.60	.60	.60
CH ₄ .....	....	....	36.00	3.60	3.59	3.60
Total	100.00	90.10	100.00	10.00	100.00	100.10
Btu. in gas	128.10	11546	573.20	4732	172.61	17278
	per cubic foot	in 90.1 cubic feet	per cubic foot	in 10.0 cubic feet	per cubic foot	in 100.1 cubic feet

There is without doubt also some fixed carbon created in the distillation zone by the breaking up of tarry vapors, which is afterwards gasified by blast. From a study of various coal and gas analyses, Table XI has been worked out, as representing average conditions in the gasification of two classes of coal, which cover nearly all the important producer gas coals in America. From this table it is seen that more tar and soot are produced from high volatile than from medium volatile coals, but the C in the fixed distillation gas is about the same as compared to pure C gasified by the blast. An average probable composition of the distillation gas is given in Table XII with the exclusion of N and H₂O and the distillation gas per pound of C gasified by blast. By adding this gas to the gas from C gasified by blast, as previously calculated, the composition of actual theoretical producer gas is obtained. The gas composition is given in Fig. 11 and the method of calculation for a gasification temperature of 2000 deg. F. is given in Table XIII. The composition of the gas represented in Fig. 11 is also given in Table XIV for more convenient use.

The Btu. in the gas per pound of C in the gas form an ideal basis for comparing the quality of various gases. This has been previously pointed out in the comparison of gas from C and coke. In case of bituminous coals it also gives excellent comparisons, if consideration is taken of the ratio F.C. to V.M. This

TABLE XIV—COMPOSITION OF TOTAL THEORETICAL GAS FROM ORDINARY BITUMINOUS COALS GASIFIED BY AIR AND H₂O AT VARIOUS TEMPERATURES OF GASIFICATION.

	Gasification temperatures			
	1600° F.	1800° F.	2000° F.	2200° F.
C ₂ H ₄	.51	.57	.60	.61
CH ₄	3.05	3.44	3.59	3.67
CO	13.80	23.22	29.10	31.36
H	17.70	15.78	13.29	11.10
Total combustibles; per cent	35.06	43.01	46.58	46.74
CO ₂	13.80	7.62	3.47	1.56
N	51.14	49.37	49.95	51.70
Total; per cent	100.00	100.00	100.00	100.00
Btu. per cu. ft.	129.31	158.87	172.61	174.80
C in 100 cu. ft. of gas	1.002 lbs.	1.121 lbs.	1.182 lbs.	1.196 lbs.
Btu. per pound C in gas.....	12905	14177	14603	14615

method of comparing gases has therefore been adopted. From analysis in Fig. 11 and Table XIV can be estimated the gasification temperature corresponding to an actual producer gas, and the Btu. per pound of C in the gas can be compared to the same figure for the theoretical gas at the same temperature of gasification. The theoretical Btu. per pound of C in the gas is shown in Fig. 12. For comparison, there are given curves for pure C as derived before (see Fig. 8) for coke and coals with less volatile matter than ordinary bituminous coals. These curves have been calculated by considering the analysis of these coals and the distillation gas that is obtained in the gasification thereof.

Comparison Between Theory and Practice.

In order to compare a gas analysis with the theoretical gas, the following operations are necessary:

1. Calculate net Btu. per cubic foot of gas, standard condition, according to usual methods.
2. Calculate C contained in 100 cubic feet of gas. This is readily obtained by the following formula from the gas analysis:
Pounds of C in 100 cubic feet of gas = $.03164 \times (\%CO_2 + \%CO + \%CH_4 + 2 \times \%C_2H_4)$.
3. Calculate Btu. per pound of C in gas from the two previous calculations:
$$\text{Btu. per pound of C in gas} = \frac{\text{Btu. per cubic foot} \times 100}{\text{Lbs. of C in 100 cubic feet gas}}$$
4. Estimate gasification temperature by comparing the gas analysis with the theoretical gas in Table 14 and read corresponding theoretical Btu. per pound of C in gas.
5. Divide the result from 3 by the theoretical Btu. per pound of C and the result gives a comparison between actual and theoretical practice.

In Table XV such a comparison is made.
Gas No. 1—Average of 12 hour samples for 66 hours run on high grade West Virginia gas coal; ratio F.C. to V.M. = 1.60, from a modern mechanically poked producer with ash zone agitation and automatic ash removal, under test conditions at a rate of about 47.5 pounds of coal gasified per sq. ft. per hour. Quality factor, 99.1.
Gas No. 2—Average for about five days run on a high grade Indiana gas coal; ratio F.C. to V.M. = 1.30, in the same producer under test conditions at a rate of gasification of about 33 pounds of coal gasified per sq. ft. per hour. Quality factor, 99.2.

Gas No. 3—Twelve hour gas sample from Illinois coal; ratio F.C. to V.M. = about 1.55, from the same producer at a gasification rate of about 48 pounds of coal gasified per sq. ft. per hour. Quality factor, 96.3.

Gas. No. 4—Average gas from a modern mechanical producer running under excellent operating mill conditions on high grade gas coal. Quality factor, 96.4.

Gas. No. 5—Average gas analysis from an open-hearth plant with good gas producer operating conditions using high grade Eastern gas coal in mechanically poked producers, but without ash zone agitation. Quality factor, 94.1.

Gas No. 6—Average gas analysis from an open-hearth plant using Pittsburgh coal in mechanically poked producers, but without ash zone agitation. Quality factor, 94.1.

Gas No. 7—Average gas analysis from an open-hearth plant using Pittsburgh coal in mechanically poked producers, but without ash zone agitation. Quality factor, 91.7.

Gas No. 8—Average gas for best month in an open-hearth plant using Eastern gas coal in a modern type producer with agitated fuel bed but without ash zone agitation. Quality factor, 96.6.

Gas No. 9—Gas produced in hand-poked producers from Illinois coal under fair operating conditions.* Quality factor 89.1.

Gas No. 10—Average gas from Indiana coal; ratio F.C. to V.M. = 1.36, under poor operating conditions.† Quality factor, 82.7.

Gas No. 11—Average gas in an open-hearth plant, with old type hand-poked producers using Pittsburgh coal. Quality factor, 89.9.

Gas No. 12—Four days sample of gas obtained in mechanically agitated producers from ordinary Illinois coal in open-hearth practice at a gasification rate of 35.4 pounds per sq. ft. per hour. Quality factor, 96.5.

*See 1922 Year Book of the American Iron and Steel Institute, Fig. 7, page 477.

†Analysis from a paper by A. S. Witting, "Judging Fuels from Gas Analysis," Association of Iron and Steel Electrical Engineers, 1922.

This comparison shows that, under test conditions, results very close to the theoretical can be obtained with good gas coal, even during a prolonged run. For shorter runs, 9 to 12 hours, results have actually been obtained, both on Eastern and high grade Indiana coals, which show 1 per cent to 2 per cent above 100 per cent efficiency. This is probably due to a difference in the distillation gas, as the assumption made of the quantity and composition thereof for various coals can only be an approximation.

The gases Nos. 4 to 11, represent mill conditions. Good mill practice is about 96 per cent on both Eastern and Western coals and is represented by gases Nos. 4, 8 and 12. A quality factor below 94 per cent can only be called fair, as represented in Nos. 7, 9 and 10. Hand-poked producers show considerably lower quality factors.

It is worthy of note that the gasification temperature, with one exception is below the temperature at which theoretically the maximum efficiency of gasification and combustion occurs, as represented in Figs. 6 and 10. On Eastern coals which have an ash fusing point of 2100 deg. to 2300 deg. F., there should not be any difficulty in using a considerably smaller amount of steam in the blast and bring up the gasification temperature, thereby making the gas higher in CO and lower in CO₂ and H₂O. Suitable blowers must of course be used. Indiana and Illinois coals generally have 100 deg. to 150 deg. lower ash fusing points, and with these one must, therefore, be satisfied with a gasification temperature of about 1900 deg. F.

Efficiency of Producers.

The definition of the efficiency of producers as used today is very indefinite. The methods of calculation vary extremely and are just as uncertain as the proper methods of defining the efficiency of the open-hearth furnace. Messrs. Kinney and McDermott, in their paper before this Institute last year (The Thermal Efficiency and Heat Balance of an Open-Hearth Furnace), suggested that it would be within the jurisdic-

TABLE XV — COMPARISON OF THEORETICAL GAS WITH PRODUCER GAS FROM VARIOUS BITUMINOUS COAL, AND ESTIMATE OF GASIFICATION TEMPERATURES.

	Theoretical Gas* at 1900°	1	2	3	4	5	6	7	8	9	10	11	12
Gas, analysis by volume:													
C ₂ H ₄	.59	.40	.50	.60	.90	.20	.30	.70	.30	.33	.40	.40	.67
CH ₄	3.53	3.10	2.80	2.80	2.70	3.10	2.80	3.00	2.70	2.86	2.60	2.90	3.54
CO	26.48	26.70	24.30	25.00	28.70	2.380	23.60	22.00	25.20	16.23	20.30	18.10	20.18
H	14.60	13.90	13.00	12.60	12.00	12.40	11.50	10.20	14.40	11.30	8.10	11.60	13.08
Total combustion	45.20	44.10	40.60	41.00	44.30	39.50	38.20	35.90	42.60	30.72	31.40	33.00	37.47
CO ₂	5.20	4.30	4.70	5.40	3.70	5.70	5.00	6.60	5.40	8.96	8.00	8.70	7.78
O ₂ .....	.....	.10	.10	.20	.....	.....	.....	.....	.20	.53	.....	.30	.....
N	49.60	51.50	54.60	53.40	52.00	54.80	56.80	57.50	51.80	59.79	60.60	58.00	54.75
Total (per cent)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Btu. per cubic foot	167.79	159.24	147.73	150.37	164.22	142.71	138.31	137.31	150.65	114.93	117.84	123.22	143.93
C per 100 cubic feet (pounds)	1.151	1.104	1.033	1.088	1.167	1.044	1.012	1.044	1.073	.908	1.003	.965	1.039
Btu. per Lb. of C in gas	14529	14424	14232	13820	14071	13669	13667	13152	14040	12657	11748	12768	13852
Estimated gasification Temperature, Deg. F.	1900	1925	1850	1850	2000	1900	1900	1850	1900	1800 to 1900	1800 to 1900	1800 to 1900	1850
Theoretical Btu. per Lb. of C in gas at this temperature, see Table XIV and Fig. 12	14529	14549	14350	14350	14603	14529	14529	14350	14529	14200	14200	14200	14350
Comparison in per cent	100.00	99.10	99.20	96.30	96.40	94.10	94.10	91.70	96.60	89.10	82.70	89.90	96.50

*See Table XIV and Fig. 11.

tion of the American Iron and Steel Institute to appoint a committee on standards for calculating the efficiency of the open-hearth furnace. This suggestion would apply with equal reason to the efficiency of gas producers.

The heat value of coals is commonly given in gross

Btu. per pound. This is not a true basis for comparing various coals, as is frequently pointed out by combustion engineers. It is unlikely, however, that this basis will be changed to the more rational net basis. In the following, therefore, producer efficiency means the net calorific heat in the gas from the producer,

TABLE XV-A — COMPARISON BETWEEN PRODUCER EFFICIENCY FOR EASTERN AND WESTERN COALS AT IDEAL, GOOD AND FAIR PRACTICE.

	Eastern coal			Western coal		
	Per cent.	Btu. per lb.	Total Btu.	Per cent.	Btu. per lb.	Total Btu.
Analysis of natural coal (per cent):						
Moisture	3.0	.....	.....	10.0	.....	.....
Ash	7.5	.....	.....	7.5	.....	.....
Fixed carbon	56.5	.....	.....	47.0	.....	.....
Volatile	33.0	.....	.....	35.5	.....	.....
Total	100.0	.....	.....	100.0	.....	.....
Total C	75.2	.....	.....	65.5	.....	.....
Btu. per pound of natural coal:						
Gross	...	13536	.....	...	11855.5	.....
Net	...	13107	.....	...	11394.0	.....
Btu. per pound of C in coal:						
Gross	...	18000	.....	...	18100.0	.....
Net	...	17430	.....	...	17395.0	.....
Distribution of total C in coal and heat therein after gasification at various practices:						
C in ash	1.2	14544	175	1.2	14544.0	175
C in soot	3.6	14544	523	3.8	14544.0	552
C in tar	5.0	16300	815	6.9	16300.0	1125
C in fixed gases:						
Ideal practice	90.2	14600	13169	88.1	14400.0	12686
Ordinary good practice.....		13900	12538		13700.0	12070
Fair practice		13200	11906		13000.0	11453
Total	100.0	.....	.....	100.0	.....	.....
		Equation			Equation	
Heat lost as latent heat in water vapor (difference between gross and net Btu.).....	3.2	$\frac{18000 - 17430}{18000}$		3.9	$\frac{18100 - 17395}{18100}$	
Heat lost in C in ash.....	1.0	$\frac{175}{18000}$		1.0	$\frac{175}{18100}$	
Heat lost in soot.....	2.9	$\frac{523}{18000}$		3.0	$\frac{552}{18100}$	
Total heat in these items.....	7.1	.....		7.9	.....	
Total heat in gas, sensible and calorific and radiated heat	92.9	.....		92.1	.....	
Ideal practice:						
Heat radiated and lost in cooling water.....	3.0	.....		3.0	.....	
Net calorific heat in total gas (fixed gas and tarry vapors). producer efficiency	77.6	$\frac{815 + 13169}{18000}$		76.3	$\frac{1125 + 12686}{18100}$	
Sensible heat in gas.....	12.3	.....		12.8	.....	
Ordinary good practice:						
Heat radiated	3.5	.....		3.5	.....	
Net calorific heat in total gas. Producer efficiency.....	74.1	$\frac{815 + 12538}{18000}$		72.9	$\frac{1125 + 12070}{18100}$	
Sensible heat in gas.....	15.3	.....		15.7	.....	
Fair practice:						
Heat radiated	4.0	.....		4.0	.....	
Net calorific heat in total gas. Producer efficiency.....	70.6	$\frac{815 + 11906}{18000}$		69.5	$\frac{1125 + 11453}{18100}$	
Sensible heat in gas.....	18.3	.....		18.6	.....	

The heat lost in radiation and cooling water is estimated and varies greatly for various producers.
The sensible heat in the gas follows from this estimate.

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divided by the gross heat value of the coal from which this gas is obtained. In the net calorific heat in the gas are included the net heat in the tarry vapors, but not the heat in the soot that is deposited before the gas reaches the place of combustion. In the coal used, the coal, or coal equivalent, is not included that is used to raise the steam blown into the producer or condensed in the steam line. The latent heat in this steam is not considered nor the sensible heat in the blast, which in ordinary practice is obtained from the steam. To include the steam item involves a number of assumptions, which vary in different plants; and in a number of cases, waste heat is used to produce the steam. The coal, or coal equivalent, used to make the electricity for operating the mechanical producers, is not considered. This item has often been taken into account, but there is no more reason to include this item than there would be to count the coal used to heat the homes of the men operating the hand-poked producer, or that needed to transport them to work.

A method for comparing the actual producer gas from the analysis to a certain high standard has been given in the early part of this paper. Such a comparison constitutes a simple method of judging the gasification without the necessity of considering the complicated producer efficiency. It follows that the higher the quality factor the higher, as a rule, is the total producer efficiency. The quality factor, however, does not take into account the loss of C in the ashes and the soot, the radiation losses, and those occurring in the cooling-water or the sensible heat in the gas. The actual efficiency of the producer must be considered when heat units in coal are compared to heat units in other fuels such as tar or coke oven gas, and when values of various fuels are considered.

It has been previously pointed out that the various present methods used for expressing the producer efficiency are all fundamentally incorrect, as they do not take account of the tarry vapors in the proper way. The tar has a net Btu. value of about 16,300 Btu. per pound of contained C.

It has been shown before that, under ideal gasification conditions the Btu. in the fixed gases per pound of C is about 14,600. The tarry vapors, therefore, increase the Btu. per pound of C in the total gas. Methods, in which all the C gasified is considered as fixed gases, give a producer efficiency of from one-half to one per cent lower than that actually obtained. This is especially true when poor gas is made. One would hardly think that such a gas as No. 10 in Table XV could be successfully used for making steel. This is nevertheless done, the tarry vapors accounting for this.

In Table XV-A the producer efficiency is calculated in ideal, good and fair practice for Eastern and Western coal. The ideal practice corresponds to the theoretical gas at about 2000 deg. F. gasification temperature for Eastern coal, and about 1900 deg. F. for Western coal (see Table XIV). Good practice corresponds to gases Nos. 4, 8 and 12, and fair practice to gas No. 7. Gases Nos. 5 and 6 give a producer efficiency about midway between good and fair practice.

The method of calculation in the table can readily be applied to actual cases. The distribution of C in the coal must first be determined in the same manner as shown and the Btu. per pound of C in the gas from the gas analysis. The producer efficiency then follows directly. To determine the sensible heat in

the gas, the exact composition, including moisture and temperature thereof, must be known.

The producer efficiency falls off with falling temperature of gasification. This follows from the figures for Btu. per pound of C in gas given in Table XIV. The theoretical efficiencies are for a gasification temperature of 1600 deg., 69.2 per cent; 1800 deg., 75.6 per cent; 2000 deg., 77.6 per cent; 2200 deg., 77.6 per cent.

To determine the exact relative values between various coals and other fuels, one must take into consideration the condition under which the fuels are to be burnt and the cost of gasification, etc., which, however, is outside the scope of this paper.

Hot Raw versus Cool Clean Producer Gas.

Hot gas is used almost exclusively in steel works and the demands are such that, in the majority of cases, cleaned gas could not be used to advantage. The cleaning of the gas removes the tarry vapors, the sensible heat, and a large part of the moisture. For open-hearth furnaces, the tarry vapors are a necessity, as a luminous flame is required. The beneficial effect of the removal of the moisture cannot counteract the loss of luminosity. The sensible heat is not essential in open-hearth furnaces and soaking pits, where the gas is preheated before combustion by waste gases. The sensible heat is, however, ultimately partially recovered in furnaces equipped with waste heat boilers and has therefore a certain value. In heating furnaces, where the producer gas enters the combustion chamber direct, the sensible heat in the gas is valuable as it raises the temperature of combustion.

There is a considerable field, however, where cleaned gas can and should be used. This occurs when gas is to be supplied to a large number of smaller heating furnaces spread over an extensive area. The gas can then be produced in a central producer plant, cleaned and distributed under pressure in a pipe system mixed with the theoretical proportion of combustion air and burnt with high efficiency. The tar extracted from the gas should be recovered, charged back into the producer and converted into fixed gases or burnt separately.

The Ash Fusing Producer.

It has been shown that a maximum gasification efficiency is obtained at a temperature of 2000 to 2200 deg. F. About 2200 deg. F. the efficiency drops off slowly until there is no moisture added to the blast. The gas from the gasification of pure C then will consist of CO and N only and contains as calorific heat 70.3 per cent of the heat in C. Only by using highly preheated blast containing moisture or waste gases can efficiencies be obtained in an ash fusing producer as high as with ordinary blast at lower temperatures. It does not seem likely therefore that the ash fusing producer will make very much headway, and its use will probably be restricted to special cases for coke or anthracite.

(To be continued)

The Variety Iron & Steel Works Company of Cleveland, O., engineers and manufacturers of conveying equipment and accessories, announce the opening of a Pittsburgh office, room 2203, Oliver Building, in charge of Edward T. Rahm, Jr. Mr. Rahm is well known in connection with the Aero Pulverizer Company.

Pair Heating

A Resume of Conditions Surrounding Present Practice in Heating Sheet Bars—Description of a Heating Furnace of New Design and Employing Two-Stage Combustion

By WILLIAM C. BUELL, JR.

PART I

THE "furnace problem" is always with the sheet mill operating executive as one of the major variables of management for without a continuity of properly heated sheet bars or "pairs" at a fair fuel, labor and upkeep cost per ton heated, production, quality and conversion cost vary through wide limits. Assuming that the furnaces conform to good prac-

This article will consider only the possible improvement which may be made in the operation of the so-called, continuous pair furnace.

Within the last two years, there has been constructed within a few miles of Pittsburgh, a heating furnace of a new type and although this furnace is heating bars for a continuous bolt making machine, the adaption of the principal used to the continuous pair furnace is only a matter of detail. The results secured with this furnace both from a combustion and economic standpoint have been so very remarkable, that the writer is attempting from an analysis of figures available, to draw some conclusions as to what results should be secured, when application is made to pair heating.

A New Furnace Type.

The present furnace is shown in Figs. 1, 2 and 3. The chamber in which the stock is heated is 39 ft. 0 in. long, 4 ft. 0 in. wide and the door openings at each end are about 10 in. high. Bars from 25 ft. to 27 ft. long are inserted through the charging door by hand and when called for by the machine operator are manually pushed to the feed rolls of the machine. The bars have a range of from $\frac{3}{4}$ in. to $1\frac{1}{4}$ in. diameter and as many as 30 bars are in the furnace heating, at one time. The requirements of the machine necessitate an even heat of about 1900 deg. F. (50 deg plus or minus) through the length of the bar and the minimum of scale.

Except adjacent to localities producing oil and natural gas in large quantities, bituminous coal will heat a

larger tonnage of steel per unit of cost than any other fuel, and it is the only fuel, the supply of which will certainly outlast the next 50 years.

Efforts have been made to overcome the extravagance of hand firing, and the unevenness of temperature and atmospheric conditions, by the use of the gas producer, the stoker and lately by pulverizing, but all who have used these methods, while admitting considerable improvement, will confess that a much greater improvement would be welcomed.

Producer gas is quite universally admitted to be the most desirable method of heating metal, when properly made and fired, but labor and upkeep conditions and cost have materially limited its application.

The so-called "lean-to" producer, in which a small producer is built integral with the furnace it serves has been quite successful in Europe, but has failed miserably in American practice from a combination

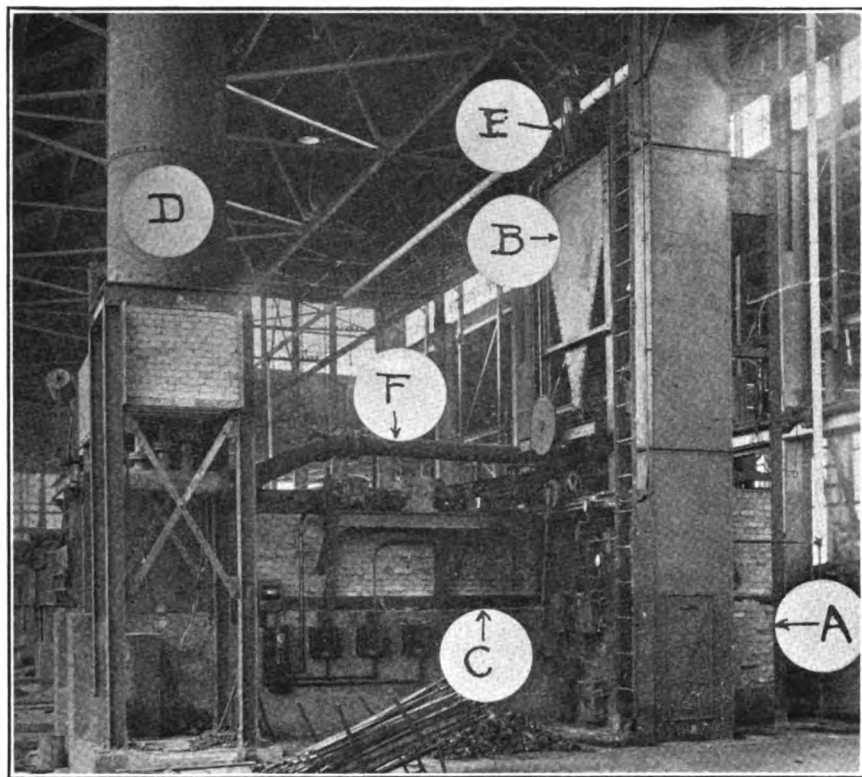


FIG. 1—An excellent view of complete installation which includes (A) producer, (B) coal hopper, (C) heating furnace, (D) stack, (E) compressed air blower, operating in a Pittsburgh steel plant.

tice as it is now understood, that the fuel available is of the proper quality for use in the system installed, then production and quality and to some extent cost, are labor problems. Cost is largely influenced by the economics of the fuel and labor markets, and consequently beyond the control of the operating executive.

The heaters usually found in the sheet mill belong to the semi-skilled class. They are called upon to manually control temperature and atmosphere within the furnace. The control of either of these factors is difficult under any conditions, and the consistent control of both within the desired limits, well nigh impossible.

Any apparatus that will remove either of these factors from the variable class, especially if crude fuels may be used, and any method that will maintain both of these variables appreciably nearer the desired constant, is worthy of most careful consideration.

of unskilled labor and the varying quality of the gas delivered. That the idea is fundamentally sound is evidenced by the large number of attempts to apply it successfully, that have been made in the United States.

In the furnace being described* the "lean-to" producer idea has been employed, but by the addition of a continuous coal feed and grate agitation, is converted into what is virtually a small mechanical gas producer delivering gas of a constant quality in volumes that may be automatically controlled from the furnace temperature. In addition to the foregoing, a unique recuperator is disclosed in the use of the stack for the container for the heat exchange elements.

Fig. 1 gives a view of the apparatus as a whole, from the control side. Fig. 2 (see March Blast Furnace), is an enlarged view of the producer front, the moving mechanism and the control (experience has shown that all control may be placed at the furnace front, convenient to the discharge door), and Fig. 3 (see April Blast Furnace), a side view, opposite to the producer side. In the case of a number of furnaces, the rather expensive drive shown in Fig. 2, may be eliminated for a central motor, driving a main shaft, and from which each furnace mechanism may be selectively driven through simple clutch arrangements.

In the photographs, "A" is the producer; "B" the hopper, holding the coal which in this particular case is elevated from the ground in the conveyor, Fig. 1; "C" is the furnace heating chamber, "D" the stack which as a matter of convenience is mounted on the substructure shown; "E" is the blower, compressing air for the secondary system, and "F" is the conduit leading the hot blast to the point of mixing with the gas from the producer.

The operation of the apparatus is as follows: Coal moves from "B" through a screw feed to the center of the roof of the producer (Fig. 3), through which it is discharged to the fire box. Partial air for combustion is delivered under the grate through a conventional steam jet blower (not shown). The products from the reaction of the air, steam and coal pass over a bridge wall into the furnace chamber, meeting at right angles the hot blast in proper quantity to complete the combustion reaction. The products then pass the length of the furnace chamber, enter uptakes at each side of the chamber at the charging end and through the connecting flue to the stack. The secondary air, compressed by the blower "E", is directed by the pipe to the top of the stack and enters a manifold from which the air passes into three pipes that extend throughout the length of the stack and terminate in a second manifold below the stack base, beginning the hot blast pipe "F".

Any solid fuel that will pass through a 2-in. screen may be used and the furnace has been operated on both high fixed carbon-low volatile, and low fixed carbon-high volatile coals with perfect satisfaction, but the preference is for gas slack.

The furnace proper is conventional excepting that a suspended arch (Fig. 3), is used, and this because it is possible for the designer to make the contour of the arch as appeared to be most desirable, or to change the contour easily if necessary.

In its operation the greatest loading of the hearth

*Application has been made for U. S. Letters Patent covering method and apparatus.

of the furnace was less than 20 lbs. per square foot as compared to 200 lbs. or more in the continuous pair furnace, but in spite of this light loading, a production in excess of 6,500 lbs. heated steel per hour has been produced. An increased loading should materially reduce fuel consumption.

As operated, the only attention given the furnace by the fireman, other than to increase or decrease coal feed and air in accordance with temperature and production requirements, is to remove the ashes twice a day, and to rake the fire for about 30 seconds, to level it, about once in two hours.

This furnace has been in operation over a year, but working only a single, eight hour turn, daily. Single turn materially increases fuel cost, for a considerable amount of coal is necessary to make the fire bed when the furnace is started in the morning and at least a similar amount of coal is on the grate at the secession of operation which is early all consumed in the 16 hour layover. This waste would be 80 per cent absent in continuous operation.

(To be continued)

Hauck Venturi Low Pressure Oil Burner

Hauck Manufacturing Company, Brooklyn, N. Y., are distributing a new booklet describing their low pressure oil burner.

The Hauck venturi low pressure oil burner is the result of many years of oil burner experience and of the efforts of our engineers to develop a burner that would—

1. Produce a clean, intense yet soft soaking flame under full control of the operator.
2. Insure perfect combustion through perfect atomization and proper air regulation—thereby saving fuel, eliminating smoke and soot or carbon deposits in the furnace chamber.
3. Light instantly on a cold furnace and bring it up to desired temperature quickly.
4. Be of sturdy construction, easily taken apart so that all parts can be cleaned and re-assembled in a few minutes.

These features are incorporated in the venturi low pressure burner and have proven their values in every installation by the extreme economy in oil and air consumption and the time and labor saved.

Modern Foundry in France

Andre Citroen, of Paris, France, commonly called the "Henry Ford of France" is now building one of the most modern up-to-date foundries in Europe. As a matter of fact it will probably be one of the best laid out foundries of its kind located anywhere.

Thorough investigations were made to determine the very best equipment that could be used in the foundry for turning out castings, particularly for automobile work, at low expense for production maintaining the necessary quality. It is quite a compliment to manufacturers of American foundry equipment that a certain apparatus in the Citroen Foundry will be manufactured in the United States, including two No. 2 6-in. diameter Simpson intensive foundry sand mixers. These machines, manufactured by the National Engineering Company, of Chicago, will be exported to France for use in the Citroen foundry.

The question of proper sand manipulation is recognized as being part of the necessary equipment to turn out an excellent quality of casting at a low price, and while French foundrymen have, for many years, recognized the necessity of using a muller type of sand mixer as exemplified in the Simpson apparatus, they did not hesitate to order the machines above mentioned from America, regardless of the considerable expense entailed in shipment.

SHEET AND TIN PLATE

Manufacturing Enameled Ware Utensils

Quality of Steel and Careful Annealing and Pickling Are Essential
to the Successful Enameling of Cooking Utensils—
Removal of Die Lubricant Impotrant

By FRANCIS G. WHITE*

ROYAL Granite enameled ware has been known to the trade for nearly 40 years. It is made exclusively at the Granite City factory of the National Enameling & Stamping Company, which covers 40 acres of ground. The enameling room, the largest of its kind in the industry, is some 1,000 feet long by 250 feet wide.

In color this ware is blue gray and is mottled on a steel gray background. It is a one coated ware, notably free from chipping, and possesses a very high gloss. With real granite in the enamel an unusually smooth and hard enamel is obtained, which is acid proof and makes an ideal kitchen utensil. With a capacity of 70,000 pieces a day, this factory is known throughout the country.

Before going into a description of the process of manufacture of "granite ware," it might be well to consider the base of the utensil—the steel. It must be remembered at the start that the cost of the steel is one of the smallest items in the ultimate cost of the finished article. Therefore, as poor steel would make a defective article in enamelware, the utmost care is taken in the melting, rolling and finishing of the steel sheet. In the manufacture of kitchen utensils on a large scale we meet certain difficulties which might not arise in a smaller plant. The first of these might be called uniformity of the steel, which would include uniform chemical analysis and annealing.

A large majority of articles are not made from one piece of steel for they may have a handle, a cover, a spout, or even may be made up of several pieces double seamed together.

Sheets are rolled to such a size that when the blanks are cut there is a least possible amount of scrap left. With the large number of sizes and gauges which must be kept in stock it is impossible to have the steel all from one heat, or even the same gauge. When three coat or colored ware is made this would not work such a hardship on the enameler, but "Royal Granite" is a one coat mottled ware and in order for an article to pass inspection it must not only be perfectly enameled, but all parts must have a similar mottle.

Chemical Composition of Steel.

Since most articles are stamped from 26 to 29 gauge sheets the phosphorous must be high enough to per-

mit rolling in these light guages. The coefficient of expansion must be similar to that of the enamel in order to prevent chipping. On a pieced article the enamel might be adjusted to "fit" the body, but unless the spout and handle were of similar composition the chipping would merely be moved from one part of the article to another part.

Very low carbon steel will not take "Royal" enamel without a considerable change in the formulae and will



FIG. 1—After blanking, the ware is drawn in double acting presses. Lubrication is necessary to prevent tearing of the metal in deep drawing.

run higher in breakage in stamping. Most enameling steels for this class of work (one coat ware) run from .08 to .12 carbon. While even higher carbon has many advantages for the enameler, the breakage increases tremendously. Manganese, sulphur, silicon and cop-

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per have more effect in the mottle than in the enameling defect—chipping. While it has been possible to control the mottle for any one steel, in a pieced article one piece of steel might have to suffer at the expense of another piece. Hence the necessity of keeping the steel uniform in analysis.

Stamping and Annealing.

Naturally the first operation would be cutting a blank from the sheet. On the lighter gauge material

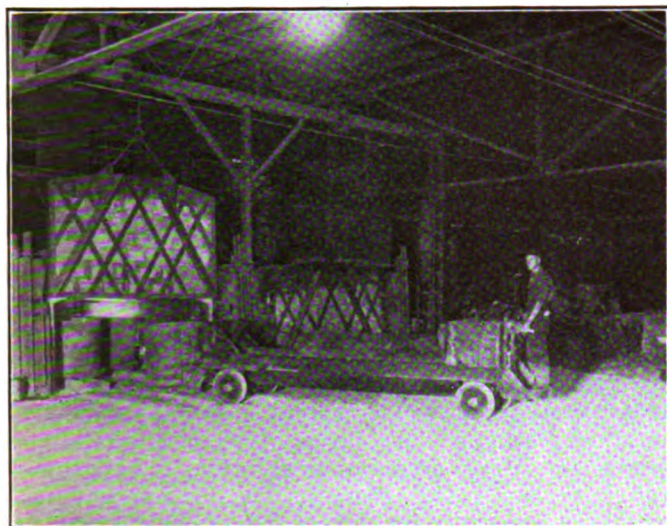


FIG. 2—Box annealing to relieve strains set up during drawing operations.

two or three sheets are blanked at a time and are usually cut in 10,000-piece lots. The shallow stamped articles, such as basins, pudding pans, etc., are made from the lightest gauge and therefore the highest phosphorous which is, of course, quite detrimental to cold working or stamping. On this type of ware breakage has been reduced more than half by turning the blanks so that the "grain of the steel" (direction of rolling) is at right angles to the other blank. This light gauge work is all done in one operation on rather light presses. Sauce pans, dish pans and kettles are stamped individually and as the article is much deeper the pressing will be done in two or more presses and frequently annealing between operations.

This annealing operation might be abandoned if the phosphorous could be kept below .010 per cent, but the gauge being so light this is impossible. On some articles it has been possible to stamp in one operation by using a double action press and lubricating the sheet with tallow in place of soap or borax water. The tallow adds quite a serious problem because of the difficulty in removing it. While a good cleaner may remove it before annealing, if the tallow has been burned on the surface (as in annealing) there seems to be some carbonizing done to the steel, which naturally makes enameling more difficult. This annealing is carried on in semi-airtight pots (being sealed with sand and clay) and since the weight of steel within the pot is quite light, from three to six hours will give a quite uniform temperature throughout.

The actual temperature will vary from 1400 to 1600 deg., depending upon whether it is a between stamping annealing or a normalizing. In order to get the desired results each annealing should be slightly hot-

ter than the previous one. Occasionally ware is burnt off or "scaled" in an open furnace. This has the effect of a very rapid annealing and in some cases has an advantage, especially if the ware is very dirty, or if an excess of tallow has been used.

For simplicity the actual manufacture of a specified article will be described, and perhaps the most popular article is a convex sauce pan or kettle. These are made in various sizes from 2 to 20-quart capacity, a 10-quart sauce pan being cataloged as "010 Convex Kettle or Sauce Pan."

A circular blank is cut of 19½-in. diameter and stamped one at a time and usually done in two operations, occasionally annealing between operations.

At the trimming and wiring department the bowl is placed in a spinning lathe and a rotary shear trims off any surplus stock, leaving about a half-inch collar which is rolled over to form a wire by a tool which follows the shear. The bowl is now completely formed as a straight sided, one-piece article and is packed in an annealing boiler, sealed up and placed in an annealing furnace for about five hours, being fired around 1500 deg. F. This annealing serves two purposes—first, to make the steel soft enough to stand the bulging operation and, second, to normalize or remove all strains from the cold working of the stamping operations. Several sized bowls will be run through at the same time, being nested inside one another in the annealing pot, but even then the weight of steel for the amount of air present is very small. Consequently the ware is fairly well scaled during the annealing and this assists in removing any tallow, oil or grease which has been used in pressing.

The bowl is then taken to an expanding or bulging press which changes it from a straight sided to a con-



FIG. 3—After annealing, the ware is pickled to remove scale and dirt, and then dipped in liquid enamel, after which it is dried and the enamel vitrified by burning in a furnace.

vex bowl. This die is made up by arranging a number of spherical segments into the shape of a spherical zone, and just before the press reaches the bottom of its stroke, a wedge is driven in the vertical axis, increasing the circumference of the zone. As the wedge is withdrawn a spring draws the segments together and the die can be withdrawn. Although this operation is quite severe because of the wire, the breakage is practically nothing, largely due to the fact that the

bowl was annealed just before this operation. The bowls are now ready to pickle, and as the bulging has loosened the surface scale the pickling is made easier.

Pickling.

Similar pickling is quite necessary to keep the mottle uniform so the handles, if a sauce pan is being made, or the ears if the article is to be a kettle, are pickled in the same tank along with the bowl. In pickling the bowls are again nested inside one another.



FIG. 4—During manufacture frequent inspections are made to eliminate defective work.

other, and after going through muriatic acid water, and soda, they are dried and taken to the welding department, where the handles or ears are spot welded and the "010 Convex" is ready to be dipped.

The enamel, after being ground and mixed with the proper amount of water, looks like a thick, rich cream, and is kept in large dish pans (dipping pans). The dipper, holding the bowl with a wire fork, immerses it in a liquid enamel, twirling it to get all parts covered, and then shakes it to remove any excess of enamel. At this stage the ware is a muddy color (the golden brown steel base altering the cream colored enamel). The sauce pan is then placed on pin points on a drying rack and as it dries the mottle forms. After it is thoroughly dry it is taken to the burning furnaces and fired. It has entered the furnace a cream yellow color with a very faint mottle design and when withdrawn, a few minutes later, it comes out a bright red and as it cools (which is very rapid) it turns a bluish gray, covered with darker gray mottles and our ware is made.

The ware is kept three days in trucks on the floor before final inspection, which gives it time to develop any chipping. It is then inspected, piece by piece, wrapped and crated.

Nickel Plating on Steel

A program of nickel plating experiments is being undertaken by the Bureau of Standards with a view to

finding the best possible process for making protective coatings on steel. A large number of specimens of steel are to be plated, and the procedure will be varied from the standard conditions in many different ways in order to test the effect on the product of these variations. After plating the specimens will be subjected to tests to determine their resistance to corrosion and to other adverse conditions that nickel plated ware is expected to meet. A few other tests will be made with nickel plating on brass and other metals in order to learn to what extent the results found for steel are generally applicable to other metals. From six months to a year will probably be required for the tests.

The program is being carried out in co-operation with the advisory committee of the American Electroplaters' Society, a committee which is appointed from the society for the purpose of co-operating with the bureau, and which meets at the bureau twice a year to discuss results and recommend investigations.

Cold rolled steel is to be used for all the tests, as it is considered desirable to have them all made on one material. In addition, the normal procedure will, in a few instances, be tried on brass. The normal procedure consists in the electrolytic cleaning of the steel and then plating it in a solution of nickel sulphate, (140 grams per liter), ammonium chloride, (13.5 grams), and boric acid (15.5 grams), the solution having a hydrogen ion concentration of 5.8. Ninety-seven per cent commercial anodes will be used, the temperature will be 70 deg. F., and the current density 5 amperes per square foot. The specimen will be plated for an hour, resulting in a coating of 0.00025 inch thickness. One side will be buffed.

Variations in preparation will be tried, such as cleaning in hot alkali, sand blasting, etc.; preliminary plating with copper, zinc, and cadmium will be tested, and many variations in the nickel plating process itself will be experimented with, such as changing the temperature, current density, composition of solution, etc. Different kinds of anodes will also be tried.

When complete, the deposits will be examined both directly and under the microscope. They will be tested for hardness, for their adhesion to the steel under such adverse conditions as bending, rolling, etc., and for the resistance they offer to corrosion under various conditions of exposure, both indoor and outdoor.

A study of special interest which was discussed at the meeting was that of the throwing power of different solutions. By this is meant the ability of the solution to deposit nickel on surfaces at different distances from the anode with a minimum of unevenness in distribution. It might be expected that any solution would put more nickel on the outside of a hollow article than it does at the bottom of a cavity, the proportion varying inversely as the distance of the surface from the anode. But it is found that this inverse law does not hold, and that some solutions give a more even deposit than do others. This results in economy of time and materials, and improvement of the finished product. If the throwing power is poor the parts of the object near the anode receive an excessive amount of nickel if a coating of adequate thickness is put on the more distant parts.

The POWER PLANT

Union Electric Light and Power Company Handle Coal With Gondola Car Dumper

**St. Louis Public Utility Finds Dumping Coal by Rotary Car Dump
Method More Economical Than by Trestle or Crane**

By E. H. KIDDER*

DUMPING a 50-ton car of coal in 1 minute 10 seconds, with only one unskilled man and a 35-hp. motor—that is the feat being performed daily by the Gondola car dumper recently installed at the new Cahokia plant of the Union Electric Light & Power Company, St. Louis, Mo.

Jules Verne, in all his wildest dreams, failed to conceive such a performance. Indeed, who could believe it possible to turn, topsy-turvy, a standard gondola car of coal, dumping the contents into a pit below, then righting the car—all in less than two minutes, with the labor (or rather, attention) of but one man together with a few cents worth of electricity! Yet this is now a reality and is one of the outstanding features of the 1923 developments in the public utility and engineering fields.

With only the first unit of the Cahokia plant completed at the present time the coal consumption averages but eight cars a day. Under the burden of eight cars a day the continued operation of the dumper seldom exceeds 20 minutes. The completion of additional units will, of course, place a greater burden upon the dumper, but it is interesting to know that with this minimum load the contractors feel the dumper pays for itself in time and labor saved. They contrast the rotary dump method with the bottom dump method, which usually requires the labor of two men for 30 minutes to unload one car of coal.

From the mechanical standpoint, the mechanism, as is the case with any rotary type of car dumper, has three distinct functions to perform, viz., the rotation of the car through an angle which will permit the discharge of the material; support of the car on its tipping side; and the clamping of the car at the top. In spite of this multiple and seemingly complicated action, the operator, in this case, has but one controller handle to operate. This controller is of the drum type, similar in design to a street car controller. And while it provides speed control, its primary function is the starting of the rotating motor. All other operations are cared for automatically by limit switches.

The gondola car dumper is made up of two distinctly separate structures. One, that of the two roller rings, 24 feet in diameter. The other being the transfer table or platen upon which the car stands.

The transfer table is carried on four rollers, two in the plane of each roller ring. The track for the rollers consists of four wedge shaped or beveled castings, attached to the under side of the transfer table.

The bevel of these castings is such that the transfer table, with the car, would move over to the side support if it were not restrained. It is held in place, however, by two hook shaped castings (C) fastened to the ends of the transfer table. Each of these castings engages a roller which is an integral part of the foundation.

As the dumper starts to rotate these hook shaped castings remain in contact with the roller, serving as a retarding device for the transfer table. That is, there is a relative movement between the transfer table and the rest of the dumper, until the car has reached its side support. The angle of the beveled plates, which causes the platen to move towards the dumping side simultaneously with the rotating movement, is approximately 6 deg. and the distance of car travel from 6 to 12 inches, depending upon the width of the car.

With the return movement the reverse of these operations takes place. The car remains supported by the side structure until the hook shaped castings engage the rollers. After engagement, the continued rotation of the dumper causes a force or pressure to be exerted between the rollers and hook castings which is sufficient to push the transfer table up the slight incline made by the slope of the beveled supports and to perfectly align the rails.

With the car in the normal position on the dumper the controller handle is in the neutral position. To begin the cycle of operations, the operator moves the controller handle into the extreme forward position. Rotation of the dumper and, as has been explained, the movement of the transfer table, starts immediately. Upon rotating 10 deg., a projection (built on the side of one of the roller rings) operates a track limit switch, which in turn, starts the top clamp motor (10 hp.). This motor pulls the four top clamps downward simultaneously, until all four clamps have become firmly seated upon the top of the car and have exerted a predetermined pull on the operating cables. When this predetermined pull has been reached it displaces an idler, which displacement operates a load switch, thereby cutting off the motor and setting a high torque brake.

*Engineer, Link-Belt Company, Chicago, Ill.

With the car firmly held to its dumping side and clamped at the top, the dumper continues to rotate until the rotating motor is automatically stopped by limit switches at the end of the rotating movement. Up to this time all the operator has done is to move his controller handle from the neutral to forward position.

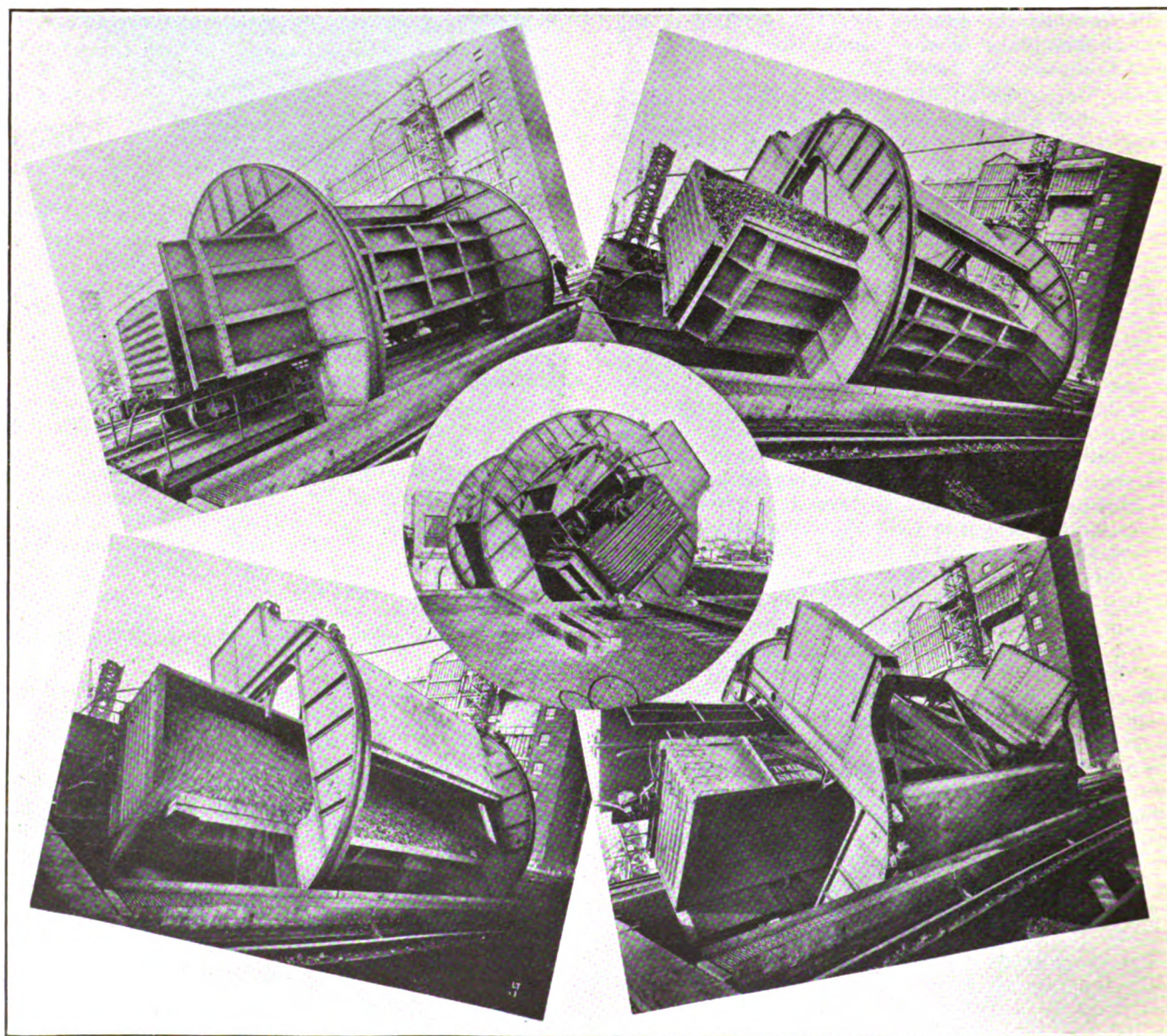
He now moves his controller handle through the neutral position and into the extreme reverse position. This reverses the direction of the rotating motor and the dumper returns to its normal position. On the return movement when the dumper is within about 10 deg. of its initial position, the top clamp motor limit switch is tripped which automatically reverses the direction of this motor and counterweights raise the top clamps to their initial position. When the top clamps have reached their uppermost position the clamping motor is cut out by a limit switch operated by one of the clamps. The rotating motor is also stopped on its return movement by a limit switch and the rails are held in correct alignment by a solenoid brake.

Without doubt the most outstanding feature of

this car dumper is its fool-proof construction and its simplicity of operation. Any operator who is capable of moving the control lever in the forward position for dumping, thence into the reverse position for the return movement, is perfectly capable of handling the entire mechanism. It is impossible for the operator to perform the cycle in any other but the correct way. The supporting of the car at the dumping side and the clamping at its top are both automatic and their operation depends solely upon the rotation of the dumper.

Another feature of this dumper is the placement of the counterweights. Extreme care was used in determining the amount and correct location for the counterweights used and the result has been the minimizing of the power requirements. The rotating motor is of 35 hp., but the entire structure is so well balanced that ammeter readings, which have been taken, indicate the size of motor furnished far in excess of the actual power required.

The gondola car dumper was designed, manufactured and erected by the Link-Belt Company of Chicago.



An assembly of five positions which illustrate the cycle of operation of a car-dumper.

Progress in the Power Field

1923 Brought Tangible Developments in Many Important
Fields of Research

By BARTON R. SHOVER*

THE First World Power Conference, to be held in London, England, June 30th to July 12th, 1923, is being promoted by the Council of the British Electrical and Allied Manufacturers Association in co-operation with technical and scientific institutions and industrial organizations in Australia, Austria, Belgium, Canada, Czecho-Slovakia, Denmark, France, Great Britain, Greece, Holland, India, Italy, Norway, Roumania, Sweden and the United States.

The objects of this conference as stated by the American Committee are as follows:

By considering the potential resources of each country in hydro-electric power, oil and minerals.

By comparing experiences in the development of scientific agriculture, irrigation and transportation by land, water and air.

It should be of interest to the steel industry of this country that Barton R. Shover, consulting engineer of Pittsburgh, has been selected to prepare the American paper on "Power in the Steel Mill Industry," to be presented at this conference. Mr. Shover is particularly well qualified for compiling a paper on this subject because his activities in the industry since 1895, both in this country and abroad, have given him a wide experience in design, construction and operation. Among the original installations standing to his credit is that of the original Gary Plant, which has more total electrical power than any other one steel plant in the country, and he enjoys the distinction of having engineered the installation of at least as much electrical equipment in iron and steel works as any other one man in the country. He is a Fellow of the A. I. E. E., members of the A. I. & S. I., and past president of the A. I. & S. E. E.

By conferences of civil, electrical, mechanical, marine and mining engineers, technical experts and authorities on scientific and industrial research.

By consultations of the consumers of power and the manufacturers of the instruments of production.

By conferences on technical education to review the educational methods in different countries, and to consider means by which existing facilities may be improved.

By discussions on the financial and economic aspects of industry, nationally and internationally.

By conferences on the possibility of establishing a Permanent World Bureau for the collection of data, the preparation of inventories of the World's resources, and the exchange of industrial and scientific information through appointed representatives in the various countries.

*Consulting Engineer, Pittsburgh, Pa.

The American Committee, as at present organized, consists of designated representatives of eight national technical and engineering societies, 12 national business organizations interested in power development, and nine government organizations. To this membership is to be added a group of individuals prominent in the fields of power development, administration and finance to be selected by the executive committee. This committee is the governing body of the general American Committee and is in charge of all preparations for participation in the conference. The honorary chairman of this committee is Hon. John W. Weeks, Secretary of War and chairman of the Federal Power Commission. O. C. Merrill, executive secretary of the Federal Power Commission is general chairman.



BARTON R. SHOVER

The Power Show in New York City, December 3-8, was a fitting climax to a year of concentration upon great power projects. The A. S. M. E. meetings, which were enthusiastically attended brought to a focus much of the intensive research which has characterized the recent year.

Holding the exposition during the week of the annual meetings of the American Society of Mechanical Engineers and the American Society of Refrigerating Engineers formed a strong attraction to techni-

cal men in New York City during that time. However, many men came from considerable distances purely to attend the show and to learn of the new devices which have been developed for the more economical combustion of fuels and utilization of power. Aside from the commercial exhibits there was an interesting series of educational exhibits and a showing of excellent motion pictures.

Educational Exhibits.

There were three purely educational exhibits, one devoted to fuels, the second to the development of the steam locomotive, and the third displaying drawings of the latest developments in modern boilers operating at high temperatures and high pressures. The exhibit of fuels was made up of sample specimens of the various kinds of solid, semi-solid and liquid fuels. The origin, analysis and heating value of each was stated. The solid fuels embraced anthracite, semi-anthracite, semi-bituminous, and bituminous, and included samples of Virginia anthracite which is beginning to attract attention. There were also specimens of cannel coal, peat, wood logs, and various forms of domestic and foreign briquetted coals. The Bureau of Mines co-operated in providing some of the samples, coke, charcoal, and colloidal fuel completed the exhibit.

The space devoted to the development, drawings, and models showing the various steps in the growth of the steam locomotive. This exhibit was prepared by the co-operation of the American, Baldwin and Lima locomotive builders and the New York Central and Erie Railroad companies. At all times there was a large crowd of spectators before it, and the management plans at the next power show to amplify the exhibit still further and give it a more prominent place.

The high-pressure boiler display was made up of a series of drawings of boilers in operation or in progress of installation each operating at 800, 1200 and 1500 lb. per square inch.

Motion Pictures.

The motion picture program, which was given twice daily, with a changing list of films in each period was made up of a large number of films provided by manufacturing companies, the United States Bureau of Mines and the Bureau of Commercial Economics, which treated such topics as water power resources, mining and preparing coal, large steam turbines, steamship Olympic, electric locomotives, locomotive building, ship building, automobile motor manufacture, airplane building, cement manufacture and nickel rolling.

The exhibits devoted to combustion equipment was probably the largest and consisted of showings of water-tube boilers, stokers, oil burning equipment, coal pulverizing and burning machinery and equipment, superheaters and economizers, air preheaters, stokers, soot blowers, grates, forced draft apparatus and ash hoppers and grates. There were several full size stokers in operation and several working models of water-tube boilers showing the paths of the water within the boiler. Construction features and methods of baffling as well as sectionalized meters and tubes were also featured. Oil-burning equipment of both mechanical and steam atomizing types attracted considerable attention. The atomizing abilities of the several burners were shown by using them to spray water in a glass case.

The exhibit of pulverized fuel equipment attracted considerable attention. One exhibitor displayed a method on conveying pulverized coal with a one-inch model of a pump which forced pulverized talc through a small pipe, through a distributing valve, to any one of a number of points as desired. Another exhibitor showed a complete pulverizing unit with a capacity of a ton of coal per hour. This was shown in motion with the cover removed. Two types of air preheaters were on view giving an opportunity to American engineers to see a device which has been effective in foreign countries, but of which there is only one large installation in this country. There were several different types of fans and turbo blowers for forced draft combustion. An ash hopper with power operated gates was shown by one exhibitor.

The exhibits devoted to boiler and turbine room instruments were probably the most interesting as the small size of the devices enables them to be shown under actual operating conditions. One exhibitor pumped water through glass pipes, showed the effect of various kinds of fittings on the flow of water. There were several V-notch meters under operating conditions, CO and CO₂ recorders, meters for coal, for water, gas, air, thermometers, tachometers, temperature controllers, draft gages, water gages, low water alarms, etc. This phase of the exposition displayed the advances in the art of measuring fluids used in power plant work, the first step in securing maximum economy of operation.

The exhibits of valves and fittings allayed any doubt there might be as to the provision of proper material for high temperature and high pressure steam plants. Many exhibits of this type of equipment used steel as the major element of construction. Motor-operated valves remotely controlled were shown by many exhibitors in actual operation. The models were in most cases sectionalized. One exhibitor presented a globe valve in which the disc swung on a lever and when the valve is open this disc is entirely out of the path of the fluid. The valve is closed with a toggle joint. A forged steel gate valve for the high pressures and temperatures encountered in oil refining was also displayed. Flared and ground joints were used and this valve is adaptable for steam at high temperatures. Other devices shown included a scheme of control for steam turbine, lead lined pipe, rapid-action hydraulic valve, flexible seat valves, and several types of steam traps in operation.

Power transmission equipment contained many interesting exhibits of ball bearings, beltings and belt drives, herringboned gearing, flexible couplings, shafting, pulleys, friction clutches, and belt fastenings. A cutless bearing adapted for service under water was shown. This bearing consisted of an outer casing of metal with a rubber inside surface ground to the required size. A spiral groove in this inner surface of rubber is devised to circulate a stream of water through the groove and prevent the bearings from being cut by any dirt in the water.

The material handling equipment featured coal and ash-handling systems, scales and weigh laries and steel conveyor apparatus. One manufacturer showed a working model of a skip-hoist with suspended coal bunker, weigh larry and grab scrapper. Steel belt conveyors and bucket conveyors were shown by others.

Refractories of all kinds were well represented, many exhibitors showed fire brick, monolithic well material, special blocks, air cooled blocks, furnace arches, clinker-proof furnace wells, and high temperature cements.

Other equipment displayed consisted of grinding machines, grates, sprockets, chains, portable boring bars for engine repairs, refrigerating machines, six-cylinder gasoline engine directly connected to a 75 kw. alternating generator, industrial trucks, Diesel engines, etc.

The problems of heating and treating boiler feed-water were considered in many exhibits. A new type of deaerator to operate without temperature drop was shown. There was a model of a large unit for water softening and filtering and a half-size model of a cooling tower in operation.

Marked Tendencies.

Several certain tendencies are marked by the year's developments:

1. The advance into new high ground of pressures.
2. The development and use of higher temperatures.
3. A keener realization of the necessities for detail improvements—such as pre-heated air, improved wall construction, better refractories—an acknowledgement that the water problem is of first importance, and must soon be approached from a definitely scientific angle; the necessity for clean steam.
4. The proper evaluation of regulation and control of all the elements involved in steam and power generation.

5. A consciousness among executives that power has become a most important phase in our total economic and social scheme, and as such, must be reduced to an engineering proportion.

As related to the steel industry, two points of attack have finally become conclusive:

1. The heat balance of the blast furnace must be immeasurably improved.
2. Open-hearth waste heats must obviously be recovered.

"When it is understood—as Mr. Siebert's excellent paper recently stated—that a modern steel plant consisting of by-product ovens, blast furnaces, open-hearth and heating furnaces with rolling mills can be designed and so balanced in fuel requirements that all needs for gas and power can be met by the output in liquid and gaseous by-product of the coke plant,

together with the output in blast furnace gas and waste heat from furnaces and engines—it will be acknowledged that as an industry steel stands in a most unique and enviable position, which can no longer tolerate the "economic crime" of poor engineering.

Steel's Relation to Coal.

The bituminous coal mined in this country is distributed among the various consumers as shown by Table II.

TABLE II.

	Cent Per	Tons Million
Railroads	28	154.0
Industries, other than steel and coke	25	137.5
Steel plants	6.4	35.2
Beehive coke plants	6.5	35.8
By-product coke plants	8.7	48.0
Electric power plants	5.7	31.4
Gas plants	0.9	4.8
Domestic consumers	10	55.0
Coal mines	2	11.0
Export	3	16.5
Seaborne	2	11.0
Foreign Trade	1	5.5
Coast and lake steamers	0.8	4.3
Total	100	550.0

The steel industry alone consumes 21.6 per cent of the total bituminous coal mined, or 106 million gross tons per year. It is therefore one of the four principal consumers. Economy effected in its fuel consuming equipment will therefore bear on a large portion of the total coal mined. Thus an improvement in economy of 10 per cent will net a saving in coal of 10 million tons per year, the value of which on a most conservative estimate is \$40,000,000. The magnitude of the sum involved is such that it should claim the most serious thought of the men who are responsible for the operation of steel plants."

The past year has witnessed a continued concentration upon the drive against combustion losses incident upon steam generation.

The following table of stoker installations emphasizes one point in this direction.

There are other losses where water is converted into steam, and used for power or other purposes—which heretofore seem to have been accepted as inevitable—but which must now be recognized as avoidable.

In the June Power Plant issue of this magazine, there appeared an article entitled "Dirty Steam No Longer Necessary"; anyone interested in the costs of steam may well refer to that article; it points the way to one of the surest recoveries of direct losses shown by the heat balance.

SIEBERT'S TABLE OF POWER TO STOVE AND BOILER EFFICIENCY

Showing effect of stove and boiler efficiency on the amount of steam which can be generated on blast furnace gas.

Heat required to raise the temperature of one cu. ft. air from 165° to 1265° F. = $1 \times 1100 \times 0.02 =$	22 B.t.u.					
Heat required for 120,000 cu. ft. air at 100 per cent stove efficiency	2,640,000 B.t.u.					
Heat required per boiler h.p.	33,479 B.t.u.					
Stove efficiency — per cent	50 80					
	Quantity Per Ton of Iron					
	Million B.t.u.	Thousand cu. ft. gas	Per cent of total gas	Million B.t.u.	Thousand cu. ft. gas	Per cent of total gas
Total gas from furnace	13.44	147	100	13.44	147	100
Required to heat 120,000 cu. ft. air to 1265° F.	5.28	58	39.4	3.29	36	24.3
Available for steam production	8.16	89	60.6	10.15	111	75.7
Boiler efficiency in per cent	50	65	80	50	65	80
Thousand B.t.u. required per Bo.h.p. hr.	67	51.5	41.8	67	51.5	41.8
Bo.h.p. can be produced per ton iron at rate of	122	158	195	152	197	243
Hourly rate of steam production in Bo.h.p.	2,540	3,300	4,070	3,170	4,110	5,070

MECHANICAL STOKERS — NUMBER SOLD, HORSE-POWER, AND KINDS OF INSTALLATION, FOR SPECIFIED MONTHS, 1923

Month	Number of establishments reporting	Stokers sold		Installed under		Fire tube boilers		Water tube boilers	
		No.	H.P.	No.	H.P.	No.	H.P.	No.	H.P.
January ..	15	145	83,270	29	3,400	116	79,870		
February ..	15	129	66,619	9	1,172	120	65,447		
March	15	120	68,955	9	1,259	111	67,696		
April	15	167	85,339	14	2,000	153	83,339		
May	15	194	100,513	14	1,915	180	98,598		
June	15	135	59,719	6	804	129	58,915		
July	15	129	52,518	21	3,454	108	49,064		
August	15	135	71,693	18	2,624	117	69,069		
September ..	15	99	60,486	16	2,754	83	57,732		
October ..	15	88	32,576	14	2,330	74	30,246		
November ..	15	50	16,241	10	1,300	40	14,941		
December ..	15	73	32,517	17	2,820	56	29,697		

Every pound of water carried away by the outgoing steam is a greater economic loss than even the percentage figures indicate.

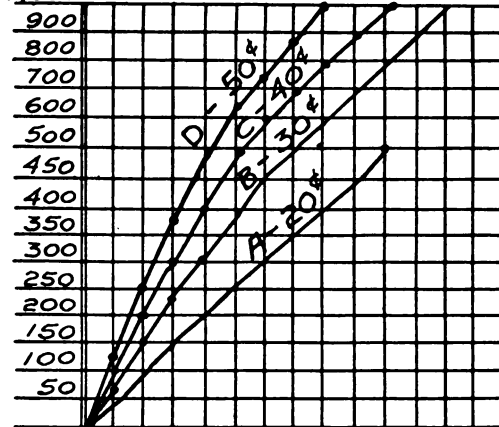
Fig. 1 approximates these losses for varying percentages of moisture, and at various costs per horsepower.

Even of greater magnitude, is the blow-down loss—that is the circulation water voluntarily withdrawn from an operating boiler, either, or both from the mud-drum blow-off valves, and the water-column. The purpose of such withdrawals being an attempt to re-

MOISTURE IN STEAM

Loss per Year

\$1000



Percent Moisture 0.5 1 1½ 2 2½ 3 3½ 4 4½ 5 %

Average

Curves Showing Losses Per 1000 H.P.

A = Steam Cost at 20¢ per 1000 H.P.

B = " " " 30¢ " "

C = " " " 40¢ " "

D = " " " 50¢ " "

FIG. 1.

duce in some degree the so-called concentrations of solids, either insoluble or soluble, which are supposed to cause foaming, or scale formation.

Ask the average boiler operator what percentage of his total input this blow-down loss amounts to and he will surprise one by his lack of positive knowledge.

One very definite reason why boiler test results are seldom realized in practice is because of this very factor. Tests are run with sealed blow-off valves, and this avoidable loss is thereby added to the actual total. At first glance this may sound erroneous—as efficiencies are figured in pounds of steam evaporated from

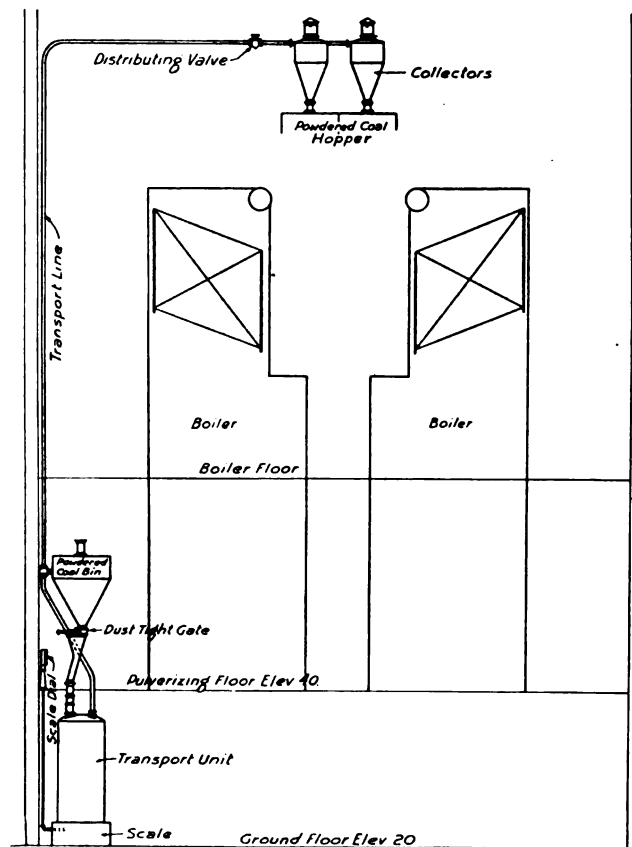


FIG. 2—Powdered coal transport system at Cahokia, E. St. Louis, Ill.

pounds of water fed, into pounds of fuel used—but where no water—which has been raised to the temperature of steam at the given pressure—has been wasted in blow-down—this difference is an advantage against actual operation where the loss takes place constantly and is seldom approximate.

Actual measurements will discover this blow-down loss to amount toward 5-8 per cent under careful operation—while under bad water conditions and careless operation the average must be assumed as higher. For a 1000 h.p. boiler, to arbitrarily place \$2,000 per year on the wrong side of the ledger is a serious handicap.

Adding these two avoidable losses together totals a recovery which many thousands of dollars invested in better combustion equipment can scarcely equal, or overcome.

The outstanding developments in pulverized fuel applications were the completion of the first unit at Cahokia station of the Union Electric Light & Power Company, located at East St. Louis, Illinois.

Details regarding the equipment used in handling the pulverized coal are interesting. See Fig. 2.

Among these, the method of weighing the fuel, and conveying it from the pulverizers to the boilers is of unusual interest.

Below the floor level of the pulverizing room are placed a series of five blowing tanks, which serve an

equal number of twin pulverizing units. These blowing tanks rest on platform scales, the dial of which indicates to the operator in the pulverizing room the amount of fuel in the tank.

The fuel feeds into these tanks by gravity as desired from pulverized fuel bins in the pulverizing room. Each charge is automatically weighed and then elevated by compressed air to a height of about 75 feet through 4-in. pipes. By means of a simple system of switching valves and parallel distributing mains, cross connected, any blowing unit can discharge into any of the eight enclosed storage hoppers in the boiler house. These hoppers serve the four pairs of boilers of 1780 h.p. each, comprising the first group of boiler units to be installed.

The fuel requirements for the first group of units is estimated at 1,000 tons in 16 hours.

The accompanying drawing shows the general arrangement of blowing tanks with relation to the boilers. Quigley Fuel System equipment was selected on account of its cleanliness and freedom from mechanical complication which would be liable to interrupt service.

The putting into service of combination blast-furnace gas and powdered coal equipment boilers by the Tennessee Coal, Iron & Railroad Company at the Ensley plant was described in January Blast Furnace and Steel Plant.

Completion of six large high-pressure boilers at the La Belle plant of the Wheeling Steel Corporation—using the same combination of blast-furnace gas, and powdered coal—but in this installation, direct firing pulverizers were selected owing to the far greater simplicity of the operation. These boilers deliver steam to the two largest unaflo engines ever constructed, rated at 12,500 h.p. at 72 revolutions but capable of developing nearly 25,000 h.p. at peak demand. A picture of one of these Nordberg giants during construction appeared in June Blast Furnace & Steel Plant.

A further experiment is now nearing completion in New York City, at the Sherman Creek Station. Six specially designed boilers of approximately 600 h.p. each are being equipt with various types and systems of pulverized coal equipment including the new high-speed Simplex unit, in order that comparative data may be obtained of the relative merits of these various systems when operated under identical conditions.

The Inland Steel Company, Chicago, Ill., has consummated arrangements for the acquisition of the plant of the Milwaukee Rolling Mill Company, Milwaukee, Wis., for which negotiations have been in progress for a number of months past. The purchase price has not been made public. The plant consists of ten sheet mills, five galvanizing pots, cold rolling equipment and other necessary rolling machinery to roll and finish about 5,000 tons of black and galvanized sheets per month. The purchasing company has plans in prospect for extensions and betterments in the plant, including remodeling of a portion of the present machinery, and will likely arrange financing for the purchase and this work in the near future. Exclusive of this new acquisition, the Inland company has a total of 18 sheet mills, all of which are now operating at capacity; the Milwaukee plant will be placed on a like basis at an early date. P. D. Block is president of the purchasing organization.

Youngstown Steel Expands

James A. Campbell, president of the Youngstown Sheet and Tube Company, has announced the company will construct two butt-weld pipe mills and a furnace at Indiana Harbor, Chicago, Ill., at a cost of \$4,000,000. The furnace is to be completed within a year and the mills by May 1. This will make a total of 22 mills owned by this company. Eleven are located in Youngstown. Total output will be about 100,000 tons a month, it is said.

ROLLING ALLOY STEEL

(Continued from page 116)

Brinell tests of the steel handled in the manner described above show that the hardness has been lowered as much as 50 points over the hot-bed piling method.

After the pile has cooled to a point where it can

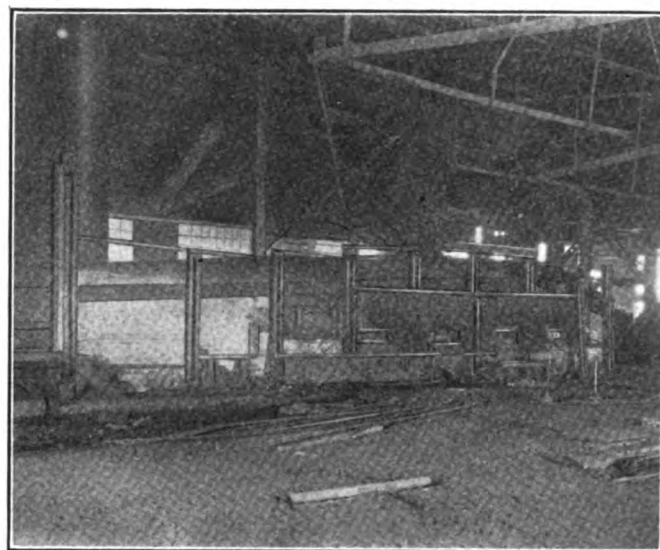


FIG 5.—Side of furnace showing the discharging doors—the final discharging door being the second from the right-hand side.

be handled by hand, the inspection corps take it up and give each piece an individual inspection before shipping.

In conclusion the efforts of the Harrisburg Pipe & Pipe Bending Company can be summarized as follows:

1. Careful heating.
2. Slow rolling.
3. No handling after rolling until the steel is properly cooled, thereby eliminating local hardness.
4. Slow cooling to get the best possible annealing effect.
5. Careful individual piece inspection.

A four-page folder recently issued by the Combustion Engineering Corporation describes the New Frederick Stoker, an underfeed, multiple retort type. Freely illustrated, it conveys an adequate idea of correct combustion practically applied. One illustration is that of the Frederick stoker in the boiler room of a large central station, which has four 14-retort Fredericks under 1608 h.p. boilers.

Power Plant Management*

By ROBERT JUNE†

IN maintaining combustion efficiency there are few factors more important than draft regulation. Without draft there would be no combustion. With too little draft huge operating losses occur. With too much draft the losses are equally large.

Draft Required for Different Fuels.

For each individual furnace there is a variable draft loss, which is affected by a number of factors. The air necessary for combustion must pass through the grate and through the fuel bed. With large openings and short passages such as occur when large uniform lumps of coal are thinly spread on a grate, the draft loss is extremely small. With fine coal, or coal of variable sizes which packs well, and with deep fuel beds the resistance to the passage of the air is very much greater. Should we attempt to supply the same amount of draft for both fuel beds, we would have with the thin fuel bed and the large lumps a condition where the coal would be rapidly burned on certain sections of the grate, leaving the fire thin at these points and as a matter of fact uncovering the

composition of the coal but the percentage of ash has a bearing on the draft required.

To sum up: there is one best draft for each boiler with a given fuel and a given rate of combustion. This best draft can be readily determined by experiment.

Draft Gauges Essential.

If you are going to operate at a draft best suited to your fuel and your rate of combustion, you must know when you have secured that draft and whether you are maintaining it. This means that the use of a draft gauge is essential.

This is the fourth in a new series of articles by Robert June, the well known authority on power plant management. The articles are written from the point of view of the managing executive and deal with the dollars and cents end of power plant operation and maintenance. Succeeding articles deal with such live topics as Safe and Efficient Boiler Operation, Stoker Operation and Maintenance, What Management Should Know about Coal and Ash Handling Equipment, Steam Piping, Efficient Turbine Operation, etc. The series is timely and should prove of value to our readers.

grates, so that there would be very large losses due to the excessive amounts of air. With the thick fuel bed offering considerable resistance to the passage of the draft, due both to its thickness and more compact nature, we should have incomplete combustion, with low CO₂, high CO and large volumes of dense smoke pouring from the stack.

Thus we find that for every kind and grade of coal, for every furnace, and for different rates of combustion in the same furnace, there is a certain draft from which most economical and satisfactory results are secured. Fig. 1 gives a good general idea of the draft required to burn a number of the most commonly used steam coals at various rates of combustion. These are not absolute figures, but simply indicate common experience. It will be seen that with the free burning bituminous coals a comparative light draft is most economical. The amount of draft required increases as the fixed carbon increases and the volatile decreases. The highest drafts are thus commonly required for small sizes of anthracite. It should be understood, of course, that not only the



ROBERT JUNE

Let us suppose that your boilers are equipped with draft gauges. Unless the firemen are making use of the information furnished them, you will be surprised at the variety of drafts which you have in your plant as you go from boiler to boiler. The trouble is this, the firemen know that draft is a good thing and their inclination is to make good use of it.

It is a universal custom in designing power plants to provide for an excess of draft. Then to throttle this down dampers are furnished. Now the great trouble is the firemen may either leave the damper wide open, or else open entirely too wide for the purpose in hand. This is on the assumption that you do not have automatic damper control, of which more

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†Associate Member A. S. M. E.

later. The point here is that the draft gauge tells the story and the damper controls it.

Suppose you have a hand fired plant, and the firemen do not adjust the dampers to the load. What then is their procedure? The answer is that they use the ash pit door for this purpose, and that this is a most expensive procedure. Close the ash pit doors and you will note that the vacuum on your draft gauge is greatly increased. The result of this is to speed up the inflow of air at all of the cracks, crevices and holes in the boiler setting. Flue gas temperature is reduced and steam production is checked, but the process is a wasteful one. The answer is—if nothing better can be done at least see to it that manual damper control from the front of the boiler, so arranged that the fireman can get at it as easily as he does the ash pit doors, is provided. Then compel the fireman to use the dampers in preference to the ash pit doors.

Now getting back to the draft gauge. You are buying this for the fireman, and he is the man to keep in mind. If the gauge tells him what he wants to know and in a way which he can understand and at the moment when he needs the information he will use it—not otherwise. Here are the points to keep in mind:

1. Provide a draft gauge for each boiler furnace.

2. Locate gauges at the most convenient and accessible point. Put them at the front of the boiler at a convenient height so that the fireman does not have to step out of his way a foot to read them.

3. See that the scales are large and easily read. If necessary provide an electric light for the gauge. An unlighted gauge is not much good in a dark boiler room.

Fig. 2 shows a typical draft gauge with a range of 74 hundredths of an inch of water.

Automatic Control.

Automatic control as applied to forced draft involves the consideration of three factors; the provision of air supply introduced beneath the fuel bed, the feeding of the fuel, and the draft over the fire. To govern these factors so that they may be utilized to the best advantage we must control the apparatus which supplies the forced draft under the fire, we must control the rate at which the stoker feeds the fuel, and we must control the damper or it may be the induced draft fan in the boiler breaching, which controls draft over the fire.

Now, first and last a good many different types of equipment have been developed for the purpose of securing automatic control. Speaking in a general sense this equipment as a class has given effective service and has effected worthwhile economies which have made it a good investment in the plants where it has been installed. Specifically, however, combustion control equipment has not always been designed and is not today always designed, on lines which will effect the greatest economies.

A straight line is the shortest distance between two points. This being the case if you want to maintain an even steam pressure the most effective means of accomplishing this result is to have the steam pressure directly control the forced draft fan. This is the direct straight line and it is a better arrangement than to have the steam pressure control the damper and then let the draft over the fire in turn control the forced draft fan. In following out this principle of reasoning we arrive at once at the proposition that two or more sources of control may perhaps be better than one. Here we run counter to

some exponents of a single source of control. Let us examine the situation as impartially as possible.

Control of Forced Draft.

Our forced draft fan is operated by an engine or motor, so that we can govern it through the medium of regulation on the steam lines to the engine, or in the electric circuit of the motor. We have the choice also of letting the governing factor be the amount of fuel supplied, the draft over the fire, or the steam pressure. Now if you want to raise steam pressure in a hurry there is one reliable and immediate method, and that is to increase the draft. Setting about the matter in any other way simply complicates the situation and increases

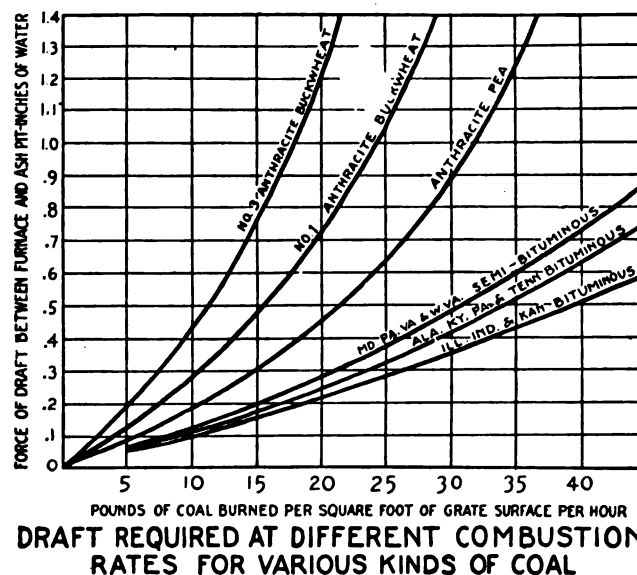


FIG. 1.

the length of time it takes to produce the desired results. Falling steam pressure is instantly compensated for by an increased draft.

Granted that this form of control is adopted you have to decide on some modification of it when more than one boiler takes air from a fan. The modification sometimes used is that of arranging to govern the butterfly gates and the air ducts leading to individual boilers, by the rate of combustion in each boiler. This does not work well in practice, since the greater the amount of combustion in an individual boiler, the greater the air supply and therefore still greater increase in combustion. In other words a condition is created whereby one boiler tends to pull the load away from another.

Therefore the proper way to handle the butterfly gates is to determine best average point at which equable distribution of the load can be obtained and then to set the butterfly gates permanently in this position. This method eliminates see-sawing as each boiler will take its share of the plant load at all times without any tendency towards "hunting."

Control of Draft Over the Fire.

The amount of draft over the fire is directly influenced by the damper. Here again the shortest distance between two points is to have the draft control the damper. The point simply is this: for each given rate of combustion there is a certain draft over the fire which assures the highest economy. An even draft can be maintained most readily by shifting the position of the damper. To let the steam pressure govern the damper is to go considerably out of our way and to have a less satisfactory result

than if we regulate the draft over the fire by means of the damper. To make this still clearer suppose we open the damper by a change in steam pressure. We then find that the damper must be open an appreciable length of time before the forced draft fan has increased the amount of gases to a volume corresponding to the opening. In the meantime the economy of combustion has been adversely affected. We need to separate very clearly in our mind these two propositions.

Proposition 1—The maintenance of steady, even steam pressure is of value only in its relation to load conditions. Governing the forced draft fan from the steam pressure is the most direct method of maintaining uniform load requirements. While highly desirable and frequently absolutely necessary it is not primarily a means of effecting economies. The saving may range from 2 to 5 per cent of fuel.

Proposition 2—Damper regulation controlled by draft over the fire is one outstanding means of effecting marked economies in combustion. Here the savings in fuel may range from 5 to 15 per cent.

Damper regulation from the draft over the fire is therefore recommended for all plants. Where there are

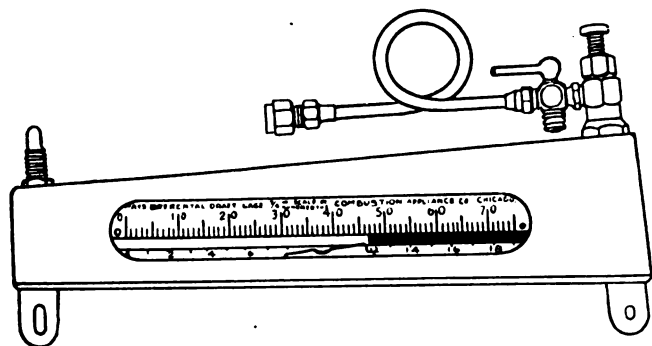


FIG. 2—Shows a typical draft gauge.

a number of boilers in a plant direct control of each damper from the draft over the fire in the boiler to which it is attached is a very much better proposition than to attempt to move all dampers simultaneously without regard to the conditions obtaining in the individual boiler.

Control of Feed of Fuel.

With mechanical stokers the feed of fuel to the furnace may be arranged to give constant steam pressure, constant draft over the fire, or it may be made to increase or decrease with the load on the boilers. The latter method is of course theoretically the best. If you could vary the amount of coal just as the load varied you would have an ideal condition. Unfortunately combustion equipment manufacturers have not yet as a class been able to solve the problem of devising a simple, efficient and dependable control of fuel feed from the steam flow. The problem is being attacked however and it seems reasonable to suppose that it will eventually be solved. When it is, it will be possible to have absolutely direct control of each factor in our combustion trio; that is we will control the air supply from the steam pressure, the damper from the draft over the fire, and the fuel feed from the steam flow.

For the present we must content ourselves with indirect control of the fuel feed. Here we have our choice of controlling the fuel feed from the draft over the fire or from the steam pressure. Utilizing the draft over the

fire for this purpose is not a satisfactory arrangement for a number of reasons. One of them is that the control must be extremely sensitive as we have a variable ranging from 0.05 to 0.15 in. of water to control a stoker which determines the output of the boiler.

This brings us back then to the control of fuel feed from the steam pressure or if preferred from the forced draft fan. Either arrangement is satisfactory and possesses the advantage that increases or decreases in the supply of coal directly corresponding with increases or decreases in the air supply. Stoker control systems designed along these lines are rendering satisfactory service in literally thousands of plants. There is no reason why they should not be unhesitatingly adopted by any power plant operator.

How Regulation Apparatus Should Be Built.

Here are points to remember in purchasing boiler room apparatus, particularly controlling devices:

1. The apparatus should be as simple and elementary as possible, telling the boiler room crews exactly what they need to know and no more. All readings should be direct so that calculations are unnecessary. Simple design is of utmost importance as boiler room men are not usually finished mechanics.

2. Strength is just as desirable as simplicity. Boiler room apparatus is subject to a good many hazards and unless it can successfully withstand bumps and knocks it is of little value. Moreover the apparatus must be able to operate accurately when covered with dust and grease.

3. The apparatus should be so designed that it can be installed by the operating engineer in charge of the plant without having to go to the expense of an erecting engineer from the manufacturers factory. Erecting engineers are highly desirable on larger equipment such as soot blowers and stokers but their expense is almost prohibitive with boiler room instruments and control devices.

4. Directions for cleaning and repairing the apparatus should be so clear that the operating engineer can understand them readily and can make the necessary repairs when required.

5. Control apparatus should be sensitive enough to maintain desired combustion conditions without hunting, racing, see-sawing, or lag.

Pumping Plant Tests

In a pamphlet entitled, "Efficiency Tests of De Laval Motor Driven Pumps," the De Laval Steam Turbine Company, Trenton, N. J., publishes the results of efficiency tests upon several large units installed in municipal water works plants. In sizes ranging from 300 to 1500 h.p. each, these units show overall efficiencies, including pump and motor, between 75 and 82.5 per cent, making possible highly economical pumping where the power is obtainable at a low price from central stations. The pumps themselves now show efficiencies practically equal to those of the best hydraulic turbines of similar capacities. A 20,000,000 Imp. gal. per day pump at Toronto, for example, showed an efficiency of 87.2 per cent, and another pump of about the same size at Baltimore is credited with 86.9 per cent, while a 12 in. pump at Newton, Mass., designed to deliver 2,000,000 gal. per day, showed an efficiency of 83.8 per cent. In view of the high efficiency of the modern motor driven centrifugal pump, and also because of its moderate requirements for space, housing, attention and supplies, this type of unit deserves careful consideration in many situations.

CURRENT TECHNICAL DIGEST

Following are some of the principal features of interest that have appeared in Iron Trade Review, January 3 to January 24:

January 3—

In this, the annual statistical issue, the world's production of pig iron in 1923 is given as 64,580,000 gross tons compared with 51,938,000 in 1922, 34,700,000 tons in 1921 and 77,182,000 tons in 1913. The world production of steel ingots and castings in 1923 was 72,573,000 gross tons, compared with 63,098,000 tons in 1922, 42,487,000 tons in 1921 and 75,019,000 tons in 1913. The output of pig iron and steel last year reached 93 per cent of that of 1913. Nearly two-thirds of the world's output of pig iron and steel was "made in America."

Production of 2,905,806 tons of pig iron in the United States in December brought the total for the year to 40,019,129 tons, the largest tonnage ever produced in one year in this country. The output of steel ingots and castings for the year was 43,226,955 gross tons, the second largest on record. Shipments of iron ore from the Lake Superior district in 1923 totaled 61,000,000 tons.

In the analysis of steel consumption by various groups in the United States it is shown that the railroads dominated all other lines. Cars and locomotives took 14.67 per cent of the output and railroad track work 12.86 per cent; building 15.77 per cent; oil, gas and water interests 10.81 per cent; automotive manufacture 10.09 per cent; exports 6.27 per cent; metal containers 3.71 per cent; machinery and tools 2.50; agricultural 2.37; street railways 1.48; mining and lumbering 1.07; shipbuilding 0.84; and other miscellaneous groups 17.56 per cent.

Reviews of industrial, business, constructional and engineering enterprises of the year are given in this issue; one of the outstanding articles being a thorough analysis of European conditions, in which H. Cole Estep, European manager of Iron Trade Review, shows that the majority of European countries are enjoying a fair degree of prosperity and that European business conditions are not as bad as indicated by those who see only the political entanglements.

January 10—

The year begins with an increase in mill bookings and release of considerable steel held back during the period of inventories. Railroad demands and building work feature the activity in the iron and steel markets. Iron Trade Review's composite of 14 leading iron and steel products moves up to \$43.21 compared with \$43.06 in the preceding week. The United States Steel Corporation is producing 83 per cent of ingot and 80 per cent of finishing capacity. Deliveries of pig iron are exceeding production with many repre-

sentative makers and several blast furnaces are preparing to resume operations.

The Ford Motor Company announces a program of extensions for 1924, which will require \$110,000,000.

Harry Coulby resigns as president of the Pittsburgh Steamship Company, Great Lakes subsidiary of the steel corporation, after 19 years in that position. A. F. Harvey, vice president and general manager, succeeds Mr. Coulby as president.

January 17—

An increase in production is the feature of the iron and steel situation this week. Bookings are running 25 to 50 per cent ahead of those in December. At Chicago, where the best improvement is noted, the Illinois Steel Company has gone from 75 to 83 per cent of ingot capacity in a week and is blowing in more furnaces. In Youngstown territory independent open hearth furnace operations are the highest since September, and in sheets, since August. A gain of 76,755 tons in steel corporation unfilled tonnage for December, the first since March, is noted. The advance in prices of scrap has stimulated demand for basic iron, a Cleveland seller having inquiries for around 75,000 tons. The price of basic has strengthened to \$22, valley. Iron Trade Review's composite of 14 leading iron and steel products this week is \$43.29 compared with \$43.21 in the preceding week.

January 24—

The volume of new business in the iron and steel markets continues to expand, and general operations are around 75 per cent of capacity. Railroads are negotiating for 40,000 cars; building constructional awards are heavy. The composite price of 14 iron and steel products is \$43.35. Pig iron prices continue to advance, while buying gives indications of a new movement, especially for second quarter iron. Inquiries and sales for the second quarter are noted especially at Chicago and Cleveland. Cleveland furnaces quote \$24, base, furnace, this week, 50 cents higher than a week ago, and have sold tonnages at this figure. Southern iron is at a minimum of \$22, some makers asking \$23. The Tennessee Coal, Iron & Railroad Company has sold 60,000 tons of iron to pipe makers. One large merchant producer in Ohio reports shipments running 25 per cent ahead of production. The Chicago market has moved up to \$24 to \$24.50.

Abroad, the iron and steel markets are affected by the strike of British locomotive engineers and the low prices offered by Belgian and German makers. British furnaces are beginning to bank.

The effect of silica on the cost of making pig iron is presented in an article giving the results of tests made by the Bureau of Mines.



For the purpose of making an intensive study of economic and business conditions in Europe and Asia, covering a period of several months, Mr. F. A. Wilson-Lawrenson has resigned his executive positions with the Union Carbide & Carbon Corporation and its various subsidiaries, with which he has been connected since 1917. Too close application to his heavy duties as vice president in charge of sales of the Prest-O-Lite Company, Inc.; of the National Carbon Company; of the American Ever-ready Works, as well as in other capacities, have made it necessary for Mr. Lawrenson to conserve his health, which his devotion and strenuous work on behalf of public and civic enterprises has somewhat impaired. The change of interests involved in the extensive travel abroad that he has planned will give him, it is thought, the much-needed relief.

Since the war period, during which Mr. F. A. Wilson-Lawrenson served the government as assistant food administrator of New York, he has been markedly prominent in public and business life. As president of the Advertising Club of New York his progressive and constructive labors did much to bring that organization into international prominence, and he was appointed by the president of the Associated Advertising Clubs of the World as a special delegate to visit London and consult with the prime minister, Mr. Bonar Law, and the leading business men and publishing interests in England as to the advisability of holding the International Advertising Convention in London in 1924. After several months' travel through England and the European countries he arranged for the visit of a huge British delegation of advertising men and newspaper men.

A Book Review by M. W. von Bernewitz
 "The Cinder Buggy: A Fable in Iron and Steel," by Gareth Garrett. 357 pages. E. P. Dutton, & Company, New York. 1923.

This is essentially the story of a town (New Damascus), or of a furnace and rolling mill plant that was the backbone of the town, which stuck to the manufacture of wrought iron, never giving way to steel, although the making of steel was tried. Interwoven is a strange partnership, during which one partner "stole" the intended wife of the other; the return years after of a son of this runaway match; his working for his father's old partner who hated him, and falling in love with the partner's daughter, and the forced marriage of the daughter to a skilled puddler. Then comes a change of scene to Pittsburgh, to where the couple and the son of the runaway partner move. The son buys a nail mill, puts the puddler in charge, and the latter makes such great changes in operation that all the nail mills, save that of the old partner at New Damascus, are combined into one company, because the industry was in a bad way. Then first comes a price war in nails with the New Damascus plant, and later, when the nail concern takes to rolling steel rails, a price war in rails—steel versus iron. Of course this is all hate and spite of the partner for the son of his old partner. Eventually the stubborn man at New Damascus gave in and died, and at his request was cremated in one of his own furnaces, which was cheerfully done by his son-in-law, the puddler. (This is somewhat akin to the Norse Vikings going to sea and setting fire to their boats.) Then comes the organizing of big steel companies, plunging on Wall Street—

rather too much space devoted to this—and labor troubles, in which the puddler, who by this time has become a great and wealthy steel man, loses his life. Eventually the son of the old runaway match marries the puddler's widow, the daughter of his father's partner, and for years his enemy. Generally, the story maintains its interest, and there are some illuminating passages on the metallurgy of iron and steel, on puddling, on mixing molten iron, on nail making, on Bessemerizing, on Pittsburgh, on human nature, and on the ups and downs of the steel industry.

The Perry Iron Company, Erie, Pa., has blown out its blast furnace and will commence work at once on the complete rebuilding of the unit. The new stack will be higher than the present one, provided with a skip hoist and other modern operating equipment. New ore bins and facilities in this department will be provided, and a new trestle erected. The estimated cost of the work has not been announced, but will run to a considerable amount. The company plans for extensive operations during the coming year.

The Alabama Company, Gadsden, Ala., has commenced work on the repairing of its local blast furnace, recently blown out, and plans to have the unit ready for service at an early date. It will be relined and a number of other improvements made, for increased operating efficiency.

The Newton Steel Company, Newton Falls, Ohio, has commenced the enlargement of the power plant at its local works, and will install considerable new equipment for increased production, including underfeed stoker, steam engine and auxiliary apparatus. It is expected to have the expansion completed at an early date.

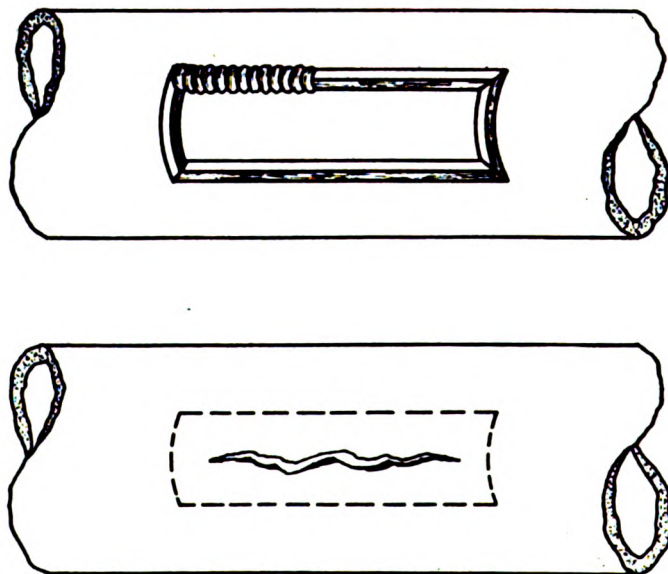
WITH THE EQUIPMENT MANUFACTURERS

Repairing a Ruptured Pipe by Oxy-Acetylene Welding

A ruptured or broken pipe in the power systems of an industrial plant is often the cause of a shutdown and concurrent serious production delays. Hence it is advisable to be prepared for such emergencies by understanding how to handle such a job and having the equipment necessary to its execution at hand when it does happen.

Forces, like so many other things, always follow the lines of least resistance so that when a break occurs at a certain point in a pipe it is usually feasible to assume that the pipe was weakest at that particular point. In repairing the break by oxy-acetylene welding (no other method is considered since this is usually the most practical), it is well to keep in mind that the metal immediately in the vicinity of the break is probably weak also and for this reason it is best to remove it for a short distance back from the break.

If the break is a longitudinal rupture, as is usually the case, it may be repaired as follows: With an oxy-

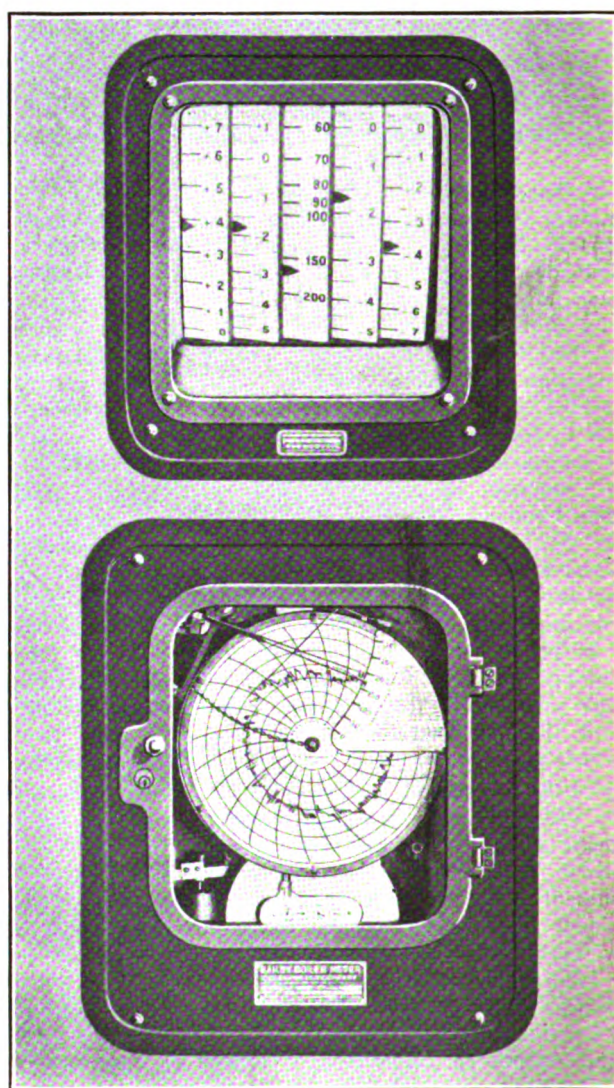


acetylene cutting blowpipe cut away the ruptured and weakened metal leaving a rectangular hole in the pipe as indicated by dotted line in first sketch. Then a rectangular patch of the same thickness and form may be obtained by cutting it from a stock or scrap length of the same size and class of pipe or it may be readily formed from a piece of sheet steel of the same thickness as the pipe wall. If this thickness is $\frac{3}{8}$ -in. or more the edges of both the hole and the patch should be beveled to a 45 degree angle with the cutting blowpipe so that when the piece is inserted a 90 degree vee will be formed thus permitting the welder to obtain full penetration of the joint when he butt welds the patch in place. (A piece of rod welded to the patch will serve as a handle by which it can be held in place during welding and is readily cut off with the blowpipe after the welding is completed.) This type of repair can be fully completed in an hour or two, can be made

at very small expense, and has the decided advantage of being permanent.

New Bailey Flush Front Meters and Gages

The scrupulous designing engineers of the modern power plants have led the Bailey Meter Company of Cleveland, Ohio, to bring out new types of metering equipment to meet the most exacting requirements. These flush front meters and gages are designed for panel board mounting and are so constructed that the meter casings and all connecting pipes are behind the panels.



The double flush front meter was designed for a boiler equipped with an economizer. Steam flow and air flow are recorded on the left hand chart, while the temperature of the feed water entering and leaving the economizer are recorded on the right hand chart. The eight pointer multi-pointer gage above this meter is suitable for installation on a boiler fired with a forced blast chain grate stoker. It indicates wind box pressure, five compartment pressures, fire box draft and uptake draft.

NEWS OF THE PLANTS

The Blair Strip Steel Company, New Castle, Pa., recently organized, has taken out a charter under state laws, with capital stock of \$100,000, and 100,000 shares, common stock, no par value. The company has work in progress on a new local mill, as recently announced in The Blast Furnace and Steel Plant, to be devoted to the manufacture of cold rolled and high tempered steel products. The initial plant will represent an investment in excess of \$75,000, and is to be ready for operating service at an early date. The new company is headed by George D. Blair, Sr. and Jr., and J. Norman Martin, all of New Castle.

The Algoma Steel Corporation, Sault Ste. Marie, Ont., has perfected plans for active operations at its new mill units and has a program to develop maximum output at an early date. Work has been commenced at the rail mill, and the merchant mill will follow into active service immediately. With one blast furnace in operation, it is planned to blow in two other units in the near future, keeping all three stacks on the active list for an indefinite period. Additional coke ovens, recently completed, will be placed in use, also, at the same time, as well as new open hearth furnaces, now about ready. It is purposed to have all departments running full in the very near future.

The Bethlehem Steel Corporation, Bethlehem, Pa., is arranging an appropriation of close to \$1,000,000, for extensions and improvements in its Cambria Works at Johnstown, Pa. The work will include several new mills, it is stated, with remodeling and betterments in existing structures, including considerable additional equipment in a number of departments. The company has work in progress at its Buffalo mill, including improvements in blast furnaces, as well as in the different mill units, and will gradually place the plant in shape for maximum output, which will be established at the earliest possible date.

The American Sheet & Tin Plate Company, Pittsburgh, Pa., is perfecting plans for extensions in its Guernsey works at Cambridge, Ohio, to include the erection of a number of new buildings, as well as improvements in the existing structures. Considerable expansion will be developed in the annealing department. A fund of \$350,000 is said to be available for the project, including the installation of additional equipment.

The Carnegie Steel Company, Pittsburgh, Pa., has plans for improvements in the open hearth department at its Farrell, Pa., works, covering the installation of 15 new waste heat boilers, each with capacity of about 450 hp., to operate on gas from the blast furnaces. The power will be used for rolling mill service and is expected to develop a considerable saving in fuel consumption at the mill. Other improvements will be made at the plant, including equipment betterments in a number of departments.

The United Alloy Steel Corporation, Canton, Ohio, has work in progress on extensions and improvements at its local mill, designed for increased output as well as greater efficiency in operation. A new gas producer is being installed, while new soaking pits are also in course of construction, to be supplemented by a new preliminary warming pit. Tentative plans are under consideration for the construction of two new continuous furnaces, as well as the erection of a new steam power plant, estimated to cost in excess of \$125,000. It is expected that additional plans will be

developed for further expansion in other departments in the near future.

The Sociedade de Usinas Siderurgicas de Santa Barbara, city of Santa Barbara, State of Minas Geraes, Brazil, has plans under consideration for the construction of two new blast furnaces at its local mills, to cost close to \$1,000,000. The stacks will be of thoroughly modern type, and are expected to utilize considerable American equipment. A new steel foundry will also be built.

The orders received by the General Electric Company for the year ending December 31, 1923, amounted to \$304,199,746, compared to a total of \$242,739,527 for the year 1922, or a gain of 25 per cent., according to a recent announcement by Gerard Swope, president of that concern. For the fourth quarters of 1923, orders totalled \$74,452,442, as compared with a total of \$66,568,333 for the corresponding quarter in the year 1922, or a gain of 12 per cent.

The Anchor Drawn Steel Company, Latrobe, Pa., has acquired a local tract of land, fronting on the Pennsylvania Railroad, and is perfecting plans for the early erection of a new mill for the manufacture of carbon steel and cold drawn products. The initial works will consist of a main one-story structure, 80x290 ft., with L-extension 50x120 ft., including power house and auxiliary buildings, estimated to cost close to \$90,000. A list of equipment to be installed, it is stated, will be prepared in the near future.

The Metal & Thermit Corporation, 120 Broadway, New York, is pushing construction on its new sheet mill on property adjoining its present works at South San Francisco, Cal., and plans to have the unit ready for service in the near future. It will be of 2-high type, with rated capacity in excess of 2,100 tons per month, including both black and galvanized sheets. The mill will represent an investment in excess of \$750,000, with equipment, and will give employment to a large increased working force.

The Seamless Steel Tube Company, Appleton, Wis., recently formed with a capital of \$400,000, has taken over a local works, heretofore used for the production of motor trucks, and will remodel and improve the buildings for company use, to total about 60,000 sq. ft. of available floor area. The initial equipment installation will consist of three finishing mills, one piercing mill and furnace, break-down mill, three annealing furnaces, six straightening machines, and auxiliary equipment, the majority of which will be electrically operated. The new plant will specialize in the manufacture of seamless steel tubing, 3 inches in diameter and smaller, and it is expected to develop a large output. The mill will be ready for service late in the summer. George J. Thust, formerly connected with the United States Steel Corporation, is one of the officials of the new company and will be in charge of production at the plant.

The National Tube Company, Frick Bldg., Pittsburgh, Pa., a subsidiary of the United States Steel Corporation, has secured an appropriation from the parent company of \$1,500,000, to be used for extensions and improvements at its plant at McKeesport, Pa. The project will include a new blast furnace, estimated to cost close to \$900,000, with mechanical charging, washing and auxiliary equipment of latest type. The remainder of the fund will be used for mill extensions and the installation of considerable additional machinery, including as well, remodeling and improving of present machinery. It is expected to inaugurate work on the project at an early date.

FEB 15 1924

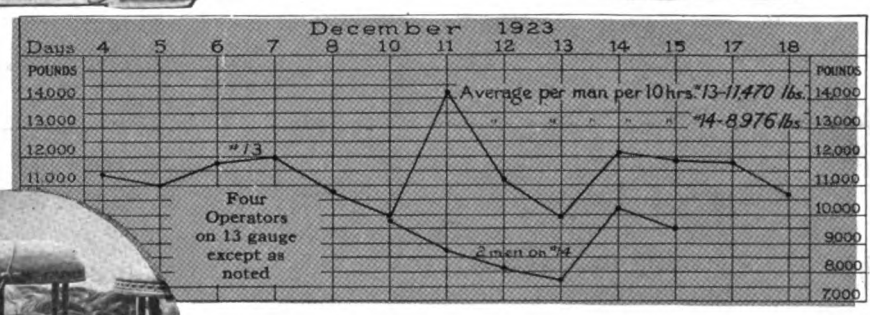
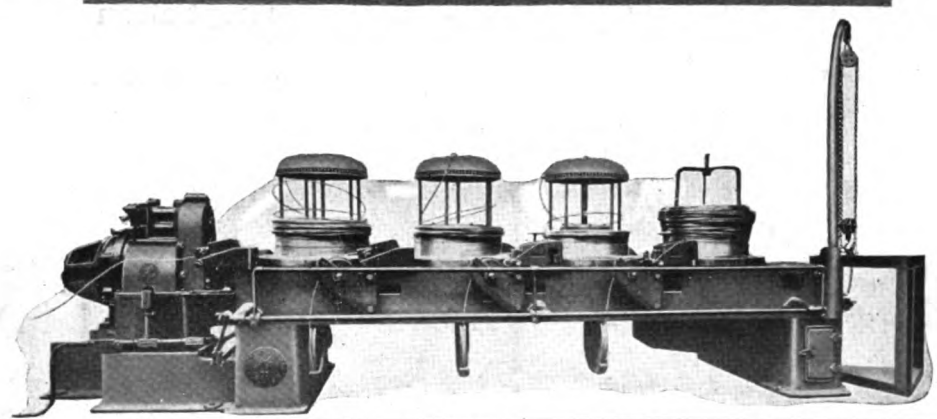
The Blast Furnace *(and)* Steel Plant

Member of the Audit Bureau of Circulations

PITTSBURGH, PA., FEBRUARY, 1924

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MORGAN WORCESTER CONTINUOUS WIRE MACHINES



High Output per Man
is the outstanding characteristic of the
Morgan-Connor Wire Machine
The chart above gives in the form of a composite curve the average output per man per day of four operators running eight machines at the Portsmouth Ohio Plant of the Wheeling Steel Corporation.

MORGAN CONSTRUCTION CO.
WORCESTER, MASS. U.S.A.

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